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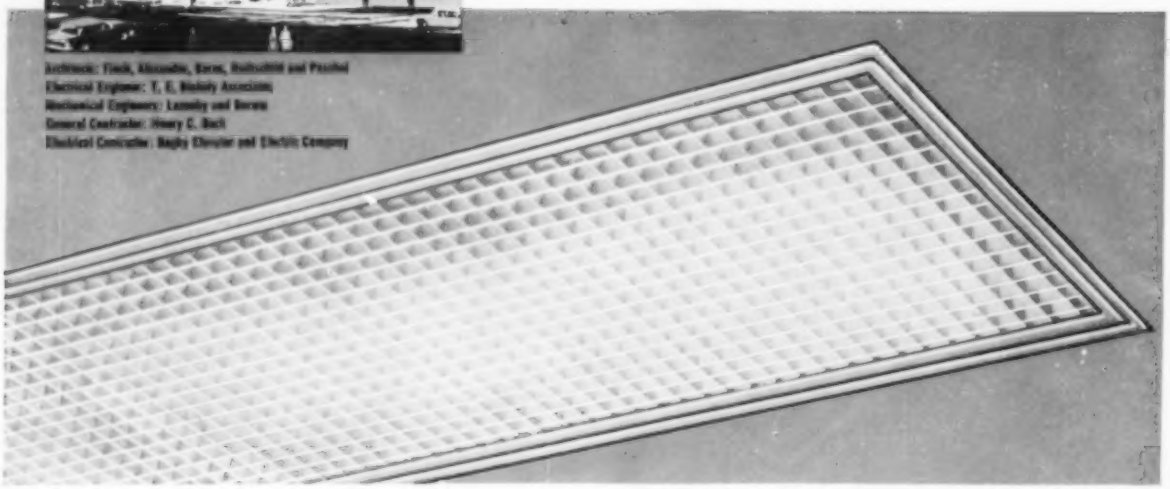
ILLUMINATING ENGINEERING

Journal of the
ILLUMINATING ENGINEERING SOCIETY

8000 WAKEFIELD TROFFERS will light new Georgia Power Company Building



Up to 200 footcandles with direct glare fully controlled. That's what the Georgia Power Company, heeding the Blackwell study, wanted for its new building—and that's what Wakefield is delivering.

Starting with a standard Wakefield 2′ x 4′ four lamp hinged and framed troffer, Wakefield engineers developed a special anodized aluminum louver that handles such high illumination levels and exactly meets the direct glare requirements of the ETL curve.

The units have no end caps and join together to create unbroken rows of light. Their shallowness (4⅞″) fits the access plenum area which is 5⅛″ deep. Some units were modified to a 4″ depth to fit a 4⅜″ plenum in certain areas, eliminating the need to lower the ceiling at those points.

Here is an excellent example of how a standard Wakefield troffer can be modified to meet a customer's particular needs. We can do as much for you.

Hinged framed louver disconnects for on-the-floor cleaning. Body is 20 gauge steel. Reflecting surfaces are infra-red white baked enamel. All electrical components carry UL labels.

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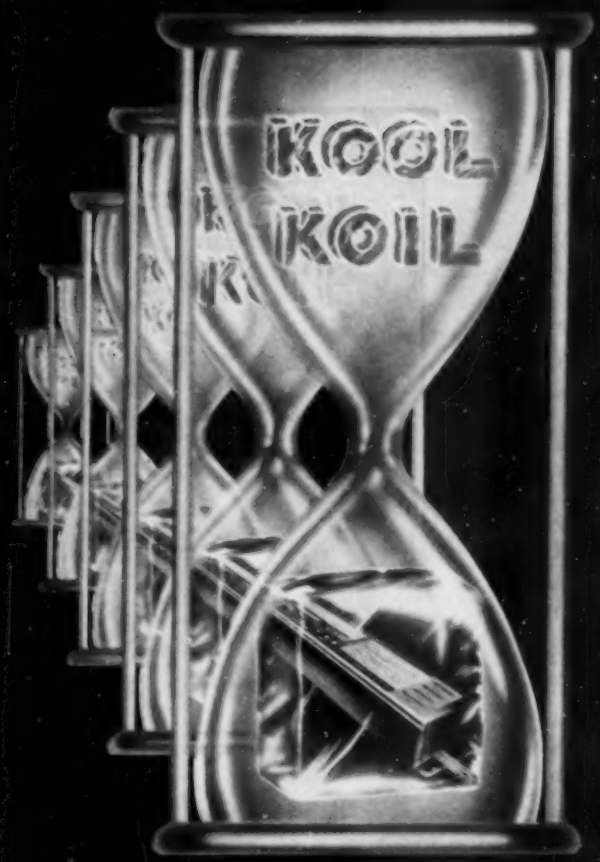

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. . . surpass the new demands, the new standards, the more exacting requirements set by commerce and industry.

Realistic thinking and years-ahead planning are earning Keystone fixtures acknowledged leadership in lighting's vastly accelerated progress.

Basic and fresh illumination concepts are here; more are to come. Keystone policy recognizes that current bold advances in lighting will soon be normal commonplaces of everyday use.

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Translucent plastic cube louver assembly, extruded polystyrene plastic side panels.

On this page, fitted to a large variety of uses, are these latest luminaires by Keystone.

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PHILADELPHIA 34, PA.

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Illuminating Engineering Society

Recommended Practice For Office Lighting

Prepared by the Office Lighting Committee of the Illuminating Engineering Society

Foreword

The Illuminating Engineering Society published its first official recommendation for office lighting in 1917 in a report entitled, "Code of Lighting Factories, Mills and Other Work Places." This code was revised in 1921 and again in 1930, each revision approved by the American Standards Association. In 1942, a new "Recommended Practice of Office Lighting" was published, the first such IES publication devoted solely to office lighting, with no industrial lighting included. That was revised in 1947 and again in 1956. This current practice incorporates new illumination levels based upon the best information available from the researches of many investigators, including that sponsored by the Illuminating Engineering Research Institute.

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1. General

The purpose of lighting is to provide efficient and comfortable seeing as an aid to office operation. It is important, therefore, to analyze the controllable factors which contribute to seeing: the *task*, the *lighting*, and the *environment*. While in practice these factors are closely interrelated, they are, for practical considerations, individually treated in this publication.

2. Office Tasks

2.1 — *General*

2.1.1 — In modern office operations, the eyes are used at close range for severe visual tasks such as reading duplicated material, handwriting, penciled stenographic notes, typing and fine print. The visibility of such work is often poor and more attention should be devoted to its improvement.

2.1.2 — The visibility of the details of a task or object is determined by its *contrast* with background, *brightness*,* *size* and *time* of viewing. Each factor is sufficiently dependent upon the magnitude of the others that a deficiency in one, within limits, may be compensated by augmenting one or more of the others. Only the factors of contrast and size, and in certain instances time, are inherent in the task itself.

2.2 — *Contrast*

2.2.1 — Each critical detail of a seeing task must differ in brightness or in color from the surrounding background to be visible. Visibility is a maximum when the brightness contrast (and color contrast if present**) of details with the background is greatest.

To illustrate conditions encountered in most office seeing tasks, the printing in this section has been shaded from a light gray at the left to a solid black at the right. The left is representative of the poor quality of characters resulting from penciled longhand and shorthand notes, the use of worn machine and typewriter ribbons, poor carbon paper, and many duplicating methods. Care should be taken to use darker inks, ribbons, carbons and pencils which will produce results as represented by the quality printing at the right.

*See Appendix A for lighting definitions and nomenclature.

**Study "Influence of Color Contrast on Visual Acuity," OSRD#4541, November 1, 1944.

[illegible] may also be reduced [illegible] lower reflectance of the background. To illustrate this factor, the [illegible] of this paragraph has been [illegible]. Most office tasks, generally [illegible] as black print on white [illegible] actually consist of shades of [illegible] degrees of lighter gray. [illegible] should be taken to avoid the use [illegible] papers which are likely to [illegible] opacity and have a low reflectance. Light tints of color are sufficient for the necessary identification [illegible] forms and need not appreciably reduce the reflectance of paper as do dark and highly saturated colors. Identification can also be obtained through the use of a colored band across the [illegible] white paper.

2.3 — *Size*

2.3.1 — Both printing and writing vary considerably in size. Type sizes in general use range from 6-point to 12-point type. As size increases, visibility increases, and, up to a certain point, readability improves and seeing becomes easier.

2.3.2—The use of this 6-point type is not desirable for continuous reading even by persons with normal vision.

2.3.3—This eight-point type may be regarded as the minimum size tolerable for good readability.

2.3.4—A more reasonable type size and, fortunately, one finding ever-increasing use for prolonged or continuous reading is this 10-point size.

2.3.5—Studies indicate the desirability of this 12-point type size for continuous reading over long periods of time.

2.4 — *Readability*

Almost all office tasks involve some aspect of reading. Readability depends upon contrast and size plus other attributes such as type face of printing or style of writing, length of

Approved by the Council of the Illuminating Engineering Society, April, 1960.

With a new black ribbon and white paper of 81% reflectance, this original typed copy has a visibility equivalent to that of 12-point Bodoni book type.

Using colored paper of about 57% reflectance, the visibility is reduced to the equivalent of 9-point Bodoni book type.

When a single carbon copy is prepared with new carbon paper on white onionskin paper, the visibility is not as good as the original, being equivalent to 9-point Bodoni type.

When multiple carbon copies are made the visibility of all is reduced as this first carbon copy of six indicates with an equivalent visibility of 8-point Bodoni type.

Those who must read the last few carbon copies have a more difficult visual task as this sixth of six carbon copies is reduced to the equivalent visibility of 7-point Bodoni type.

Figure 1. Even with the best of office materials and equipment, visibility varies among similar visual tasks. These samples were typed on an electric typewriter on which the key pressure was increased to compensate for the multiple copies made. A new black ribbon and new carbon paper of good quality were used, yet the variation in visibility is apparent from inspection.

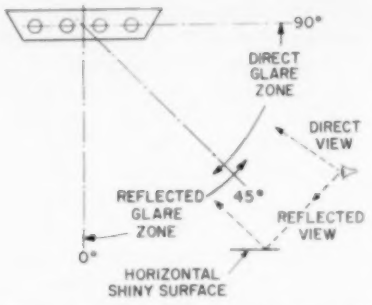


Figure 2. The direct and reflected glare zones are generally defined as shown by the above diagram. It should be noted that there is no sharp line of demarcation between these zones at 45 degrees.

lines, spacing between lines and width of margins. Similarly, individual rules, lines and guides on various office forms will have certain degrees of visibility, but the over-all readability can vary considerably, depending upon the coordination of the various elements.

3. Influence of Lighting on Seeing

3.1 — *General*

(a) Light is needed for seeing and the amount required for good seeing is greater than that required for mere discernment. The brightness resulting from the amount of light on a task can be controlled more readily and extensively than can the other factors of seeing—contrast, size and time. Brightness is therefore used to compensate for deficiencies in the other factors.

(b) It is essential that the application of light conform with certain fundamentals which contribute to comfortable seeing. These are briefly described as the quantity and quality of illumination. Quantity is important for efficient accurate seeing. Quality is essential to the creation of a comfortable environment and visual efficiency.

3.2 — *Quality of Illumination*

There should be no compromise with quality in office lighting because it is this element of the installation that determines the degree of seeing comfort that will prevail. The factors involved in lighting quality are many and complex, involving considerations of brightness, brightness ratios, light distribution, specularity of materials, diffusion and color. Installations extremely deficient in lighting quality are easily recognized as glaring, uncomfortable and inefficient. However, more moderate deficiencies are not readily detected although the cumulative effect of even slightly glaring conditions can result in loss of seeing efficiency and in undue fatigue.

3.2.1 — *Glare* — If anywhere within the visual field or fields viewed by an office worker in the course of a day's work, there are brightness conditions that reduce visibility — that cause visual discomfort — or that are visually annoying — they are categorically described as glaring. For systematic analysis, those in the field of view that are directly associated with the source of lighting and its immediate surroundings are classified as causing *direct glare*. Those directly associated with the visual tasks and their immediate surroundings are considered as contributing to *reflected glare*.

3.2.2 — *Direct Glare* — **(a)** Unshaded windows are a frequent cause of direct glare. They often permit direct view of the sun, bright portions of the sky, and the brightness of adjacent buildings. These often constitute large areas of very high brightness in the usual fields of view. The condition may be controlled by employing shade, blind, louver or baffle systems on windows. Current practices in fenestration design are described in Section 5.1.

(b) Luminaires which are too bright for the environment in which they are located produce direct glare. The eyes are quite susceptible to glare in the zone from the line of sight, which seldom is higher than horizontal, to about 45 degrees above (Fig. 2).

(c) Progress has been made in quantitatively evaluating the comfort or discomfort aspects of direct glare. Glare is reduced and seeing is improved by:

(1) *Decreasing the brightness* of the light sources and lighting equipment.
(2) *Diminishing the area* of potentially glaring high brightnesses.
(3) *Increasing the angle* between the glare source and line of sight.
(4) *Brightening the surroundings* against which the glare source is seen, but not increasing the surround brightness excessively to a point where the surround becomes a glare source (*e.g.*, an overly bright ceiling with an indirect lighting installation).

(d) Until recently, luminaire brightnesses have generally been specified, measured, and reported as *maximum* brightnesses (the brightest square inch at any given angle). Investigations have indicated, however, that *average* brightness is a more pertinent criterion, and such data are now usually provided on test reports in addition to

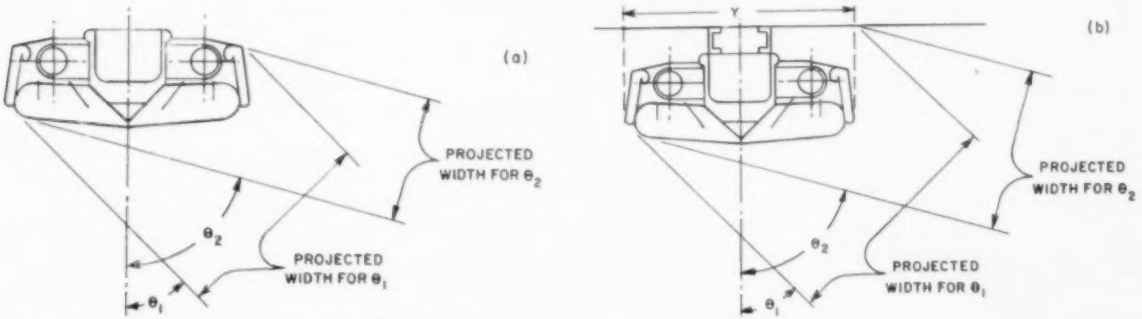


Figure 3. Projected widths for use in calculating the projected area for the average brightness calculations. (a) For all mounting except close to the ceiling mounting as explained in Section 3.2.2(c). (b) For close to the ceiling mounting. Crosswise projected area is the length times the projected width. Endwise projected area is the width times the projected length or the width times the length times cos θ.

maximum brightness data. Also, average brightness data now are included frequently in manufacturers' literature.

(e) The average brightness of a luminaire at a particular angle is determined by dividing the candlepower at that angle by the projected area (in square inches) of all the light generating and controlling elements of the luminaire that are seen at that angle. All angles are measured from nadir (vertical below luminaire). Fig. 3 illustrates how a scale drawing may be used to determine the crosswise projected area of a typical direct-indirect luminaire; lengthwise projected area would be the product of the length times the width times the cosine of the angle from vertical. To ensure uniformity in average brightness computations, the following should be observed:

(1) Air space containing no light generating or controlling elements should not be included as a part of the area.

(2) Opaque side panels of luminaires to be pendant mounted may be included as part of the projected area if at least 15 per cent of their total output is in the 100- to 140-degree zone and if the side panel has a high reflectance.

(3) End panels should not be included as projected area since the usual continuous row installation eliminates the end panel for most luminaires in the field of view.

(4) Computations of average brightness should be made at 10-degree intervals from 45 to 85 degrees.

(5) For luminaires having a mounting position of six inches or less from the top of the luminaire to the ceiling and which without ceiling mounting deliver 25 per cent or more of their light in the 90- to 180-degree zone, the projection of a ceiling area of luminaire length and of a "Y" width should be included in the luminaire projected area provided the reflectance of the ceiling is in accordance with Table I.* The "Y" width is the vertical projec-

*In calculating projected area for luminaires which are surface-mounted tightly against the ceiling so that the upward light is not visible on the ceiling neither opaque side panels nor the "Y" dimension on the ceiling should be included. For luminaires of circular design the "Y" dimension should be considered to be diameters of circles.

TABLE I.—Recommended Surface Reflectances for Offices.

Surface	REFLECTANCE "Center-point" Value and Tolerances	REFLECTANCE Equivalent Range
Ceiling Finishes*	.80 + 15%	80 — 92%
Walls	.50 ± 20%	40 — 60%
Furniture	.35 ± 25%**	26 — 44%
Office Machines and Equipment	.35 ± 25%**	26 — 44%
Floors	.30 ± 30%	21 — 39%

*Recommended reflectances are for finish only. Over-all average reflectance of acoustic materials may be somewhat lower.
**American Standard Office Reflectances Z2.1.3, 1954, UDC 535.312:651.2

TABLE II.

Any luminaire whose average brightness at each of the angles in the table below does not exceed the brightnesses in any single column of the table will comply with the intent of the limitations described in paragraph 3.2.2 (f).

Angle	Average Brightness (Footlamberts)								
85°	250	240	230	220	210	200	190	180	165
75°	250	250	250	250	250	250	250	250	250
65°	250	265	280	295	310	325	340	355	375
55°	250	285	315	350	385	415	450	480	535
45°	250	310	365	420	480	540	600	660	750

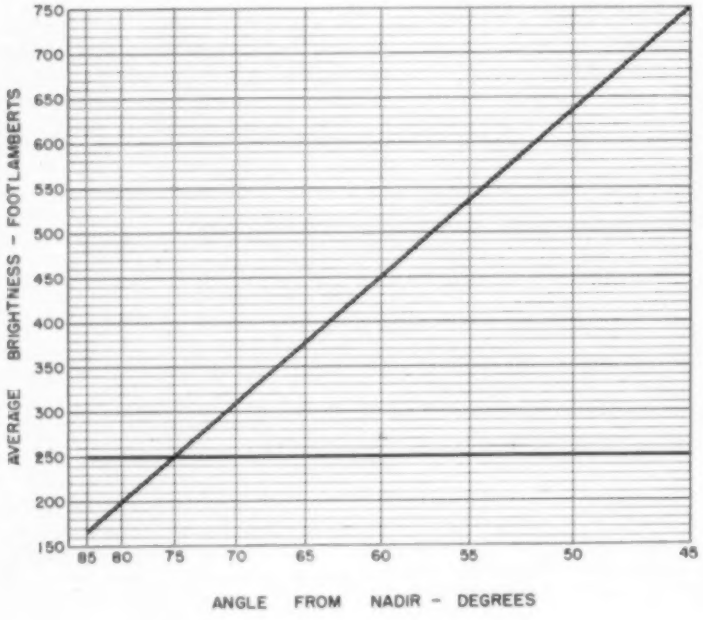
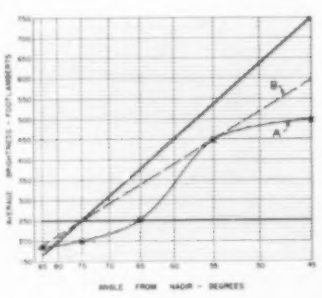


Figure 4. (left). Direct glare limiting brightness guide. Direct glare should not be a problem in 30- to 100-fc fluorescent installations if ceiling and wall reflectances comply with Table I and luminaires have crosswise and endwise brightness distributions falling entirely below any straight line drawn through 250 fL at 75 degrees, lying between the two limiting curves. Crosswise and endwise distributions need not fall below same limiting guide line. Below: Sample luminaire average brightness plot (A), limiting guide line (B).



tion of the luminaire upon the ceiling. (See Fig. 3.) The average brightness calculations should be based upon the candlepower obtained from the combination of luminaire and simulated ceiling having an 80 ± 3 per cent matte white reflectance (see "IES Guide for Photometric Testing of Fluorescent Luminaires").

(f) Careful study of data from researchers together with experience in the field suggests Fig. 4 as a means of limiting luminaire brightnesses, both crosswise and lengthwise, to comfortable values when the provisions of this Practice with regard to illumination levels and brightness conditions are also followed, including ceiling and wall reflectances given in Table I. The brightness distribution of the luminaire should be determined by plotting the average brightness at 10-degree angular intervals from 45 to 85 degrees. Table II gives brightness distributions for several typical limiting curves and may be used instead of Fig. 4, if preferred. The sloping line indicates that brightnesses at high angles are more significant in causing direct glare than at low angles for a luminaire of non-uniform brightness. When designing for the higher illumination levels appearing in Table III even greater care should be exercised in brightness control.

(g) The use of *average* brightness as the primary criterion for direct glare is based upon the assumption that office personnel seldom work with line of sight above horizontal. If the eyes are directed at the luminaires themselves, the effect of non-uniformity in their brightness distribution is more evident. Furthermore, marked non-uniformity may prove distracting. To prevent this, there should be a limit of maximum to average brightness. The ratio should be checked at each angle where the maximum brightness occurs in the 45- to 60-, 60- to 75- and 75- to 87-degree zones. Brightness at angles greater than 87 degrees are not in view, even in the largest rooms. This ratio of maximum to average brightness preferably should not be more than 3 to 1, and in no case should it exceed 5 to 1, nor should the maximum brightness for a given angle ever be more than three times the average brightness shown for that angle on the sloping line of Fig. 4. The maximum brightness should be the brightest square inch (square or circular).

(h) It is evident from 3.2.2 (c) (2) that luminaire brightness limitations

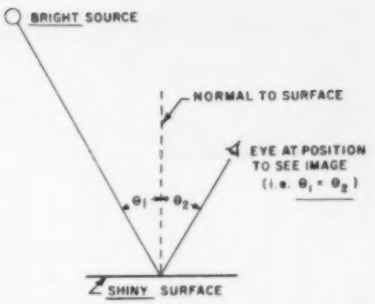


Figure 5. Reflected glare occurs when shiny surfaces including detail reflect images of bright sources of illumination toward the eye.

are more stringent for large luminaires and large offices than for small ones. The limitations suggested in paragraph (f) are based upon large luminaires such as fluorescent luminaires in large offices. Because higher brightnesses are permissible for luminaires of smaller area, luminaires which have an area of approximately one square foot projected area at zero degrees, may have double the brightnesses indicated in paragraph (f). It is recognized that in small offices the brightness at the highest angles may not be significant* and the brightness limitations for these angles could, therefore, be disregarded without impairing seeing comfort.

3.2.3—*Reflected Glare*—**(a)** Reflected glare may occur within the visual task itself or in the area immediately surrounding the task. It occurs when shiny surfaces reflect images of bright sources of illumination toward the eye (Fig. 5). Such reflections in the task itself veil the detail and reduce visibility. Source reflections in shiny surfaces immediately adjacent to the task can be distracting, uncomfortable, and can reduce ability to see.

(b) The main controlling factors related to reflected glare are:

(1) Degree of specularity (shininess) of task and surround.

(2) Reflectances of task and surround.

(3) Direction of light reflected from the task and adjacent area.

(4) Amount of illumination contributed

*The highest significant angle may be determined by making a cross-sectional sketch of the office with an occupant seated (eye level 4 feet above floor) in the least favorable location (at one end of room) viewing the most remotely located luminaire drawn in at its proposed mounting height and location.

TABLE III.—Recommended Illumination Levels.

These recommended levels are commensurate with the difficulty of the various groups of seeing tasks and the general cost of lighting. Higher values than those given are desirable and with proper lighting quality and environmental conditions will result in more efficient visual performance.

Illumination should not be permitted to fall below values specified in the table. Initial values of illumination will have to be greater by a percentage sufficient to compensate for the depreciation expected, as outlined in Section 7.4.

Some visual tasks are on slanting or vertical surfaces where illumination is only one-half to one-third of that on a horizontal plane. Compensation should be made for such tasks and for work locations at the sides of a room where illumination is usually less than in the center.

Type of Office or Work	Footcandles on Task*
Cartography, designing, detailed drafting	200
Accounting, auditing, tabulating, bookkeeping, business machine operation, reading poor reproductions, rough layout drafting	150
Regular office work, reading good reproductions, reading or transcribing handwriting in hard pencil or on poor paper. Active filing, index references, mail sorting, critical visual tasks in conference rooms	100
Reading or transcribing handwriting in ink or medium pencil on good quality paper, intermittent filing	70
Reading high contrast or well-printed material, tasks and areas not involving critical or prolonged seeing such as conferring, interviewing, inactive files and washrooms	30
Corridors, elevators, escalators, stairways	20**

*Minimum on task at any time.
**Or not less than ⅓ the level in adjacent areas.

Figure 6. Change in the appearance of printed matter due to different directions of incident light. (Viewing angle, θ_2 in Fig. 5, is 25 degrees.) Angle of incident light, θ_1 in Fig. 5, is 0 degrees in (a), 25 degrees in (b), 50 degrees in (c) and 85 degrees in (d).

by the glare source as compared with the total illumination on the task and adjacent area.

(5) Brightness and size of the light source.

(c) All of these factors should be controlled insofar as is practicable to provide the best seeing conditions at the task. To this end the following recommendations should be observed.

(1) The task and its surround should be matte (non-glossy). Matte surfaces such as good office bond paper, light-colored matte desk tops, satin or wrinkle-finished furniture and business machines disperse reflected glare to a large degree. Glossy printing inks and pencil lines, however, remain a difficult problem, for the reflection of bright areas in printed or written characters or areas materially reduce the visibility of the characters by reducing their brightness contrast with the usual light-colored background. In fact, this veiling effect may be more serious than reflections from glossy papers. See Figs. 6 and 7. It is, therefore, recommended that low gloss inks be used and specified in preference to pencil work.

(2) By using materials having a high reflectance for the task and the surround, reflected glare may be made less noticeable, but the reflectance of the surround should not exceed that of the task. Light source reflections stand out against dark glossy finishes (Fig. 8) but virtually disappear in high reflectance diffuse surfaces (Fig. 9).

(3) Locate work surfaces with respect to the fenestration and electric light sources so that the image of the source is reflected away from the observer's eyes (Fig. 10). Existing installations may be easily and quickly checked for such reflections by moving a mirror about the seeing area. The absence of any source image will ensure the virtual elimination of reflected glare. The relative orientation of the task, work area, and luminaires or fenestration can often be coordinated in the layout stage if it is remembered that the angle of reflection equals the angle of incidence. Shiny, curved surfaces may, however, reflect annoying highlights regardless of orientation; they should either be eliminated or recommendation (5) below should be followed.

(4) Light sources should be so located that the illumination on the task comes from several different directions. Thus, if some luminaires or luminous areas are of necessity located at positions where they will cause reflected glare, other luminaires or portions of large area sources at different locations will provide favorable illumination that reduces the veiling effect produced by the offending light sources or luminous areas.

(5) When it is not possible or practical to observe any of the recommendations which are given above, special precautions as to fenestration and luminaire brightness in the reflected

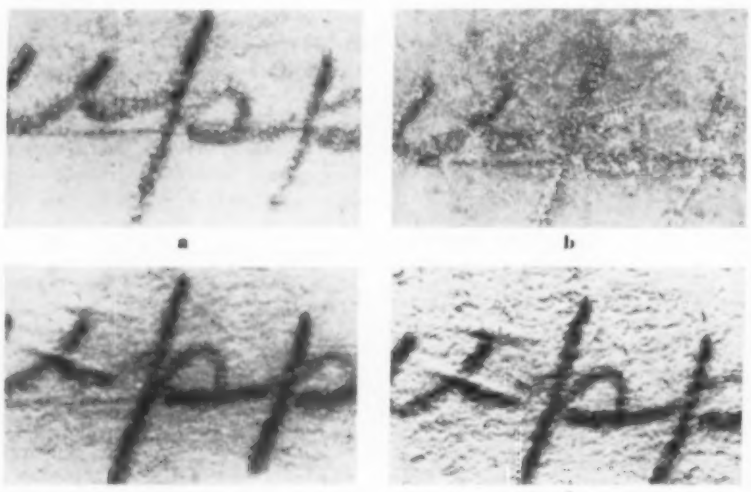


Figure 7. Change in appearance of pencil writing due to different directions of incident light. (Viewing angle, θ_2 in Fig. 5, is 25 degrees.) Angle of incident light, θ_1 in Fig. 5, is 0 degrees in (a), 25 degrees in (b), 50 degrees in (c) and 85 degrees in (d).

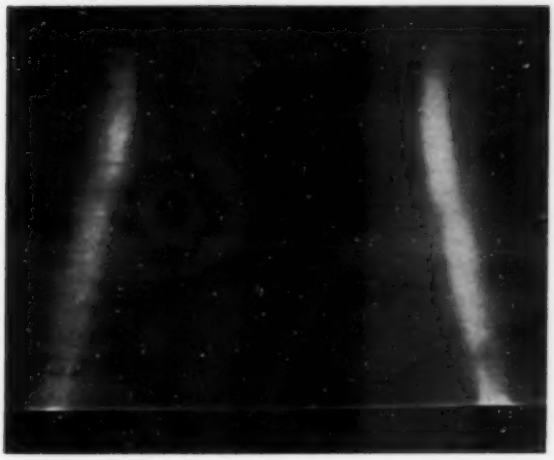


Figure 8. Streaks of light are reflected images of two continuous rows of luminaires. Very severe glare condition is produced by top which is both dark and polished.

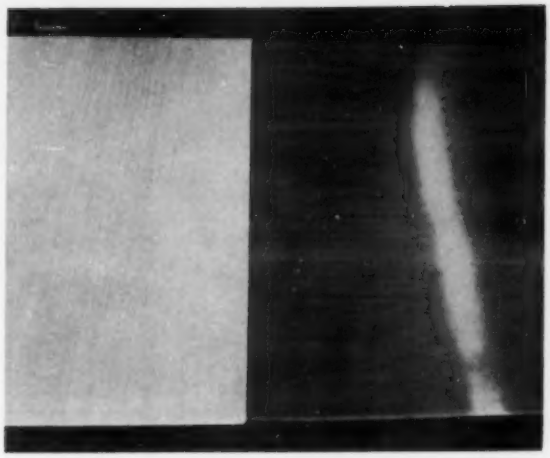


Figure 9. The reflected glare from luminaires disappears when a piece of light diffuse linoleum is placed over the dark, polished desk top.

glare zone should be observed. Luminaires and fenestration having *maximum* brightnesses (brightest square inch) in the order of 350 footlamberts (0.75 c/in^2) — and less — have generally proven to be satisfactory.

3.2.4 — *Illumination Uniformity*—**(a)** Office lighting systems should be designed to provide satisfactory uniformity of illumination to permit flexible arrangement of office operations and equipment and to help assure more uniform brightnesses throughout the office area. Uniformity of illumination is considered satisfactory if the minimum value (often between luminaires) is two-thirds or more of the maximum value (often under the luminaires). If the minimum value is half or less of the maximum, perceptible differences in illumination exist.

(b) To achieve satisfactory uniformity, it is essential that the lighting equipment be spaced in keeping with its light distribution characteristics and the physical characteristics of the room. Most manufacturers publish maximum spacing to mounting (or ceiling) height ratios* which should not be exceeded for their luminaires, and data are also available for predicting the daylight distribution from various types of fenestration. In most instances, the distance between luminaires and the wall should not exceed one half the distance between luminaires, and where desks are along the wall the distance between luminaires and walls should preferably be 2½ feet and in no case should exceed one-third the spacing between luminaires. The ends of continuous rows of fluorescent luminaires should preferably be within 6 inches to 1 foot of the wall and in no case more than 2 feet from the wall.

3.2.5 — *Shadows* — **(a)** Shadows cast *on the visual task* reduce the brightness of the task and hence impair effective seeing. When sharply defined at or near task, shadows are annoying.

(b) Shadows will be softened if the light comes from many directions. High reflectance matte finishes on room surfaces become effective secondary light sources and materially reduce shadows by reflecting a significant amount of diffused light into shadowed areas.

3.3 — *Quantity of Illumination*

(a) The lighting recommendations in Table III are based on conservative interpretations of presently available laboratory data. They are graded according to the difficulty of the visual tasks encountered in offices and drafting rooms and associated areas. These recommendations represent levels that are practical from the standpoints of techniques and economics.

(b) The illumination values given in Table III are minimum values which should be provided on the visual task, regardless of its location in the room, or other conditions which would reduce the illumination level. An allowance should be made for such conditions

Figure 10. A lighting unit positioned at "A" is an inherent source of reflected glare in the desk top, whereas at "B" there is little likelihood of its causing this complaint. When the flexibility of layout permits, full advantage should be taken of such opportunity. In most instances, freedom from reflected glare must be accomplished by proper finishes on desks and other work surfaces and by proper luminaire brightness.

*May be determined for direct and semi-direct luminaires by "Classification of Luminaires by Distribution," Report of I.E.S. Committee on Illumination Performance Recommendations, ILLUMINATING ENGINEERING, November 1954.

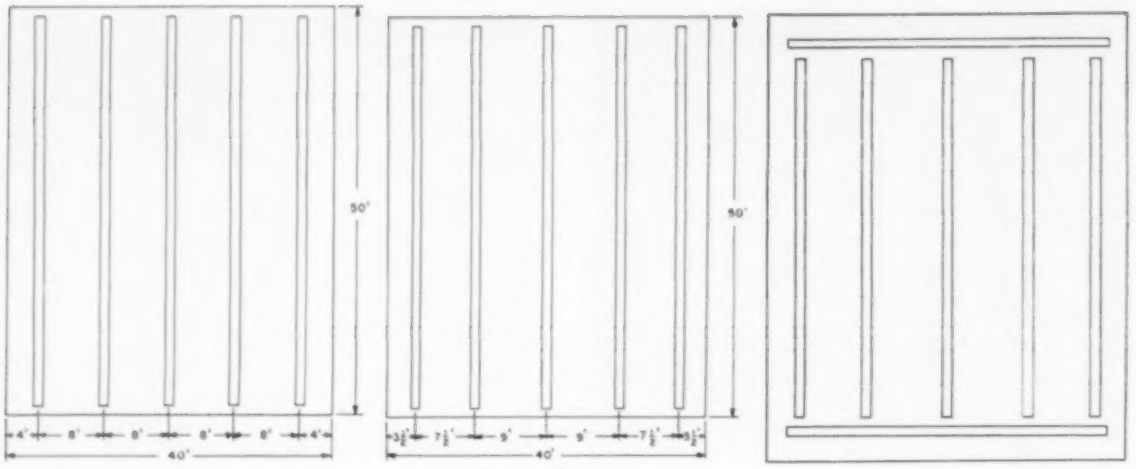


Figure 11. (a) Lighting layout using equal spacing between continuous rows of luminaires. (b) Layout is changed to provide more illumination near side walls. (c) By adding four more four-foot units on each end, layout (b) can be modified to provide 80 per cent more light near the end walls and prevent possible scallop effects.

when computing the average illumination by the lumen method. The lighting system should also be designed so that illumination will not fall below the specified level at any time in service. Regular cleaning of luminaires and room surfaces, and group relamping (or prompt replacement of burned-out lamps) will help to maintain the necessary level with the minimum total investment. A detailed discussion of lighting maintenance is presented in Section 7.4.

4. Influence of Environmental Factors

4.1 — *General*

The eyes function most comfortably and efficiently when brightness ratios within the entire field of view are not excessive. A comfortable brightness balance in the room may be achieved by selecting luminaires in accordance with the recommendations outlined in Section 3.2.2 and employing matte finishes having the reflectances recommended in Table I and Fig. 12. By observing these recommendations, brightness ratios (see Table IV) will generally be within the limit established as being desirable and practical.

4.2 — *Room Finishes*

(a) The room surfaces (ceilings, walls, and floors) are important factors in determining the brightness ratios between the lighting equipment and its surroundings. The use of matte finishes having the recommended reflectances helps prevent excessive brightness ratios and specular reflections.

(b) The reflectances of room surfaces, as well as room proportions, have a considerable effect upon the utilization of light. Ceilings, walls, and floors act as secondary light sources of large area and, if finished with the recommended reflectances, will increase light utilization and reduce shadows.

(c) Although wall reflectances should generally fall within the range of recommended reflectances, under certain conditions higher or lower re-

TABLE IV—Recommended Brightness Ratios.

To achieve a comfortable brightness balance in the office, it is desirable and practical to limit brightness ratios between areas of appreciable size from normal viewpoints as follows:

1 to 1/3	Between task and adjacent surroundings
1 to 1/10	Between task and more remote darker surfaces
1 to 10	Between task and more remote lighter surfaces
20 to 1	Between luminaires (or fenestration) and surfaces adjacent to them
40 to 1	Anywhere within the normal field of view

These ratios are recommended as maximums; reductions are generally beneficial.

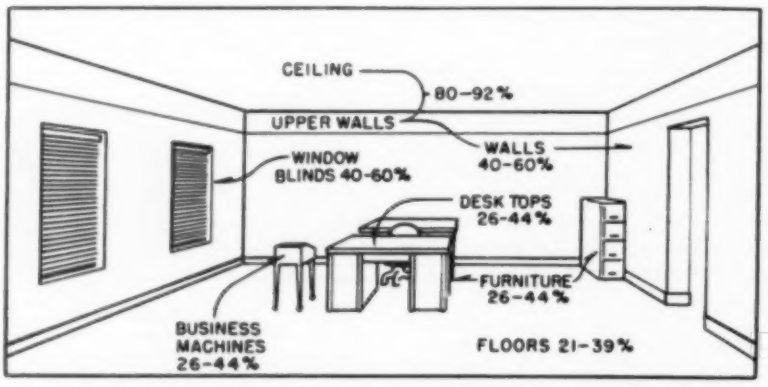


Figure 12. Reflectances recommended for room and furniture surfaces in offices.

flectances may be satisfactory or even desirable. The ceiling finish may, for example, be carried down the walls to the level of luminaires having a high upward component; utilization may be increased as much as 10 per cent by doing this. Conversely, a darker dado is sometimes employed on lower walls to minimize maintenance. Dados should have a reflectance of at least 25 per cent, however; darker dados are undesirable from the standpoint of visual comfort since the lower wall occupies an important part of the visual field. Small sections of walls may have reflectances higher or lower than the extremes permitted by the range given in Table I. If these areas are thought of as accents and restricted to about 10 per cent of the total wall area in the room, little harm will be done to the efficieney of the lighting system or to the significant environmental brightness ratios, while the environment can be made to look considerably more pleasant and interesting. Entire walls having reflectances higher or lower than the extremes permitted by the range given in Table I should be used only with discretion and by an experienced designer who recognizes the precautions that must be taken.

(d) When window shielding media act as walls they should have at least as high a reflectance as that recommended for the walls.

4.3 — *Office Equipment Finishes*

4.3.1 — *Furniture* — **(a)** No surface in the office is more important visually than the desk top. For a person working at a desk, the top occupies most of the visual field. The task is usually of high reflectance, and desk tops having the reflectance recommended in Table I are necessary to prevent the brightness ratio between the task and its surround from exceeding one to one-third ratio that is considered desirable and practical (Figs. 13 and 14). Matte finishes are, of course, essential to minimize reflected glare (Fig. 15).

(b) All office furniture should have a light finish that harmonizes with the environment and promotes seeing comfort by minimizing brightness ratios between the various surfaces within the visual field. It is particularly important that the vertical surfaces of desks and file cabinets have finishes

Figure 13. Dark desk tops such as this have reflectances of only four to seven per cent. Resulting excessive brightness ratios between work and desk top (frequently greater than 1 to 1/10) create an uncomfortable seeing condition.

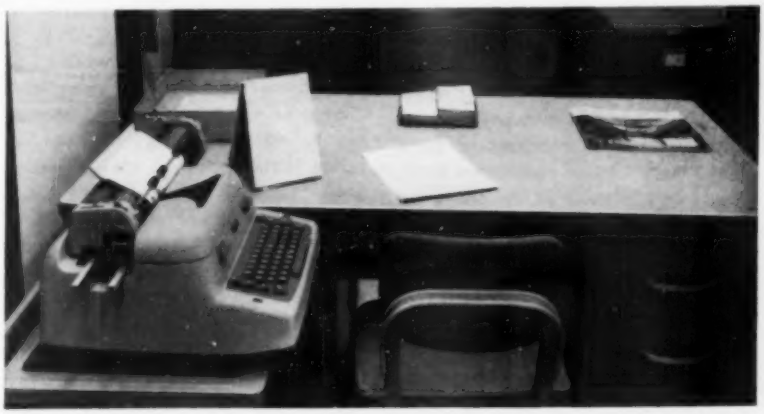


Figure 14. Desk tops of recommended 35 per cent reflectance result in brightness ratios on the order of two to one between the work and these surfaces. Under conditions of extreme dirt accumulation on such tops, the ratio will seldom exceed three to one. It is important that light finishes be employed on office business machines as shown here.

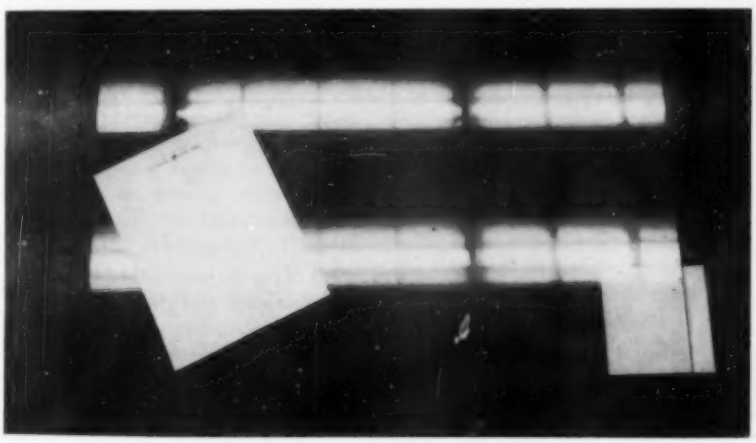


Figure 15. Images of luminaires become pronounced on glass-topped desks. The brightness of these images will frequently exceed that of the work and may actually conceal reference material under the glass.

of the recommended reflectance, for they occupy a significant portion of the visual field. Since these surfaces receive less illumination than adjacent horizontal surfaces, light finishes are necessary to make them even moderately bright.

4.3.2 — *Machines* — Business machines rank with desk tops in visual importance. In use they occupy a central and dominating part of the visual field even when operated by the touch system. Finishes having the recommended reflectances are essential for seeing comfort; shiny surfaces and dial covers should be completely eliminated, for even a small amount of specular trim can be distracting and annoying even though it may not be viewed directly.

4.4 — *Color*

4.4.1 — *Color and Office Surfaces* — **(a)** The hue or number of hues selected for an office area depends upon the size of the area, the type of work performed by the occupant or occupants, the number of consecutive hours the occupant spends in the office, the orientation of the office, and the type, condition and amount of furniture needed for the operation of the office. Color preferences of the occupant (or occupants) may be a helpful factor.

(b) If the office is small it can be made to appear larger and less crowded if walls, woodwork, and furniture placed against these walls are in the same hue or are of the same reflectance. A contrasting color or a lighter or darker value of the same color may be used at some point or points in the room. This note may be in the draperies, the upholstery for chairs or sofas and any added wall decoration, such as pictures. Small touches of accent color will give vitality and dramatic interest to a room.

(c) If the office area is not well proportioned, it is possible through the intelligent use of color to make it seem less awkward. The use of light values for backgrounds makes the office appear larger. One or two (adjacent) walls in a color different from that of the others is also helpful. The ceiling should be matte white. The appearance of high-ceilinged rooms is improved and the lighting efficiency is increased if the ceiling paint is carried down along the top of the walls.

(d) Because it is human nature to desire at least occasional change, architects and lighting designers will be wise to specify the reflectances for all surfaces in an interior and plan the lighting so the colors can be changed without destroying the planned effect. If this information is included in the specifications and marked on all blueprints anyone can not only do the original color for the room but any replacement color plan as long as the lighting system is in use. The person planning the colors for the interior should have a knowledge of color harmonies and an understanding of the importance of maintaining the recommended reflectances. Then the lighting system, the color for the environment desired, and the architecture will have unity and flexibility.

(e) In large offices the similarity of desks and equipment arranged in a repetitive pattern tends to give a sense of coldness, stiffness and monotony. Change of pace and points of interest can be effected through the use of varied patterns in wall space. Gradations, variations and accents of color, areas of figured wall paper, items and objects of interest break up monotonous continuity and provide focal points of attractiveness. This should be done carefully to preserve a sense of harmonious unity to the whole interior.

4.4.2 — *Color and Light Sources* — **(a)** Offices have been electrically lighted for over fifty years. At the beginning only incandescent filament lamps were used. Today, however, the fluorescent lamp is the principal light source in office lighting.

(b) The light from incandescent lamps enhances the warm colors of materials (the reds, oranges and browns), giving a generally warm atmosphere. At the same time the cool colors (the blues and greens) are subdued by comparison although there is usually no general consciousness of this condition because of our familiarity with the appearance of materials lighted by incandescent lamps.

(c) Many commonly-used fluorescent lamps produce cool atmospheres. Contrary to experience with incandescent lamps, blues, greens and certain yellows are emphasized and oranges, reds, browns and red purples are subdued. Therefore, cooler effects can be obtained with the use of certain fluorescent lamps, including an approximation of average daylight.

(d) Since the advent of fluorescent lighting a number of additional lamp colors have been developed, including those providing about the same warmth of light as that provided by incandescent lamps. Each fluorescent lamp color possesses certain distinguishing characteristics. Making the most advantageous selection from these various types may be complex because of the decorations and activities encountered in various offices.

(e) As a guide to aid in the selection of an appropriate fluorescent lamp color, the following discussion is presented.

(f) If an over-all atmosphere of warmth (similar to that obtained with incandescent lamps) is the objective for an office, a warm quality white fluorescent lamp, which makes the colored objects and surfaces in a room appear somewhat the same as they would under incandescent light, may be used.

(g) If an atmosphere more nearly resembling average daylight (not the coldest blue daylight) is desired and a color rendition more nearly related to daylight is sought, a cool quality white fluorescent lamp is used.

(h) These two qualities of white light from fluorescent lamps make possible either a general atmosphere of warmth, as obtained from the incandescent lamp, or complete departure from this warmth to a whiter over-all atmosphere. In the opinion of some, the latter creates a newer, cooler, and often fresher atmosphere. In over-all color rendition the cool quality white fluorescent lamp may be expected to be somewhat the better of the two.

(i) Improved-color quality may be achieved with both warm and cool white fluorescent lamps which impart an even better appearance to colors of room furnishings, foods and complexions. These improved-color-rendition lamps bring out the fuller beauty of the reds, oranges, browns and purples as well as the yellows, blues and greens.

(j) The choice of fluorescent lamp is simply a matter of deciding whether a warm or a cool atmosphere is desired for any room. When color rendition is important, the corresponding improved-color-rendition warm or cool lamp is chosen. Otherwise, the regular warm or cool white lamp would be the choice. It should be noted, however,

that improved-color-rendition is obtained at some sacrifice in the efficiency of the light production.

5. Lighting Systems for Office Areas

5.1 — *Daylighting Systems*

5.1.1 — *General* — **(a)** Fenestration areas can serve at least three useful purposes in offices. They can provide for the admission, control and distribution of daylight for seeing, provide a distant focus for the eye and thus relax important eye muscles, and eliminate the dissatisfaction many people experience in completely closed-in structures.

5.1.2 — *Important Daylight Considerations for Office Areas*—**(a)** Detailed discussion of daylighting principles will be found in the I.E.S. "Recommended Practice of Daylighting." The following are interpretations of the pertinent passages of this practice.

(b) *Building orientation and site conditions* — The fenestration system should be developed to suit the orientation, variations in topography, and landscaping related to each exterior wall (Fig. 16).

(c) Brightness control devices adapted to the control problems encountered should be provided for all fenestration areas (Fig. 17).

(1) *North elevations*—No direct sunlight will strike near-vertical surfaces within about 20 degrees of true north during the usual work day. Therefore, the control media should be designed for the sky, cloud and nearby object brightnesses that may be experienced in the range of 500-5000 footlamberts.

(2) *Sunny elevations*—With fenestration areas frequently receiving 9000 or more footcandles, special attention must be given to glare control and daylight distribution on these elevations.

5.1.3 —*Effective Utilization of Daylight* — **(a)** Daylight illumination distribution is improved when light is introduced through more than one room surface.

(b) Care should be taken to provide brightness control for the narrow continuous windows often associated with fixed fenestration systems.

(c) To provide adequate daylighting of interior corridors or other areas located more than three times ceiling height from an exterior wall, toplighting may be required (Fig. 18).

(d) Suitable fenestration materials for offices include single and double-glazed plate and window glass, both clear and heat-absorbing, combinations of clear and obscure glass, plastics, and glass blocks.

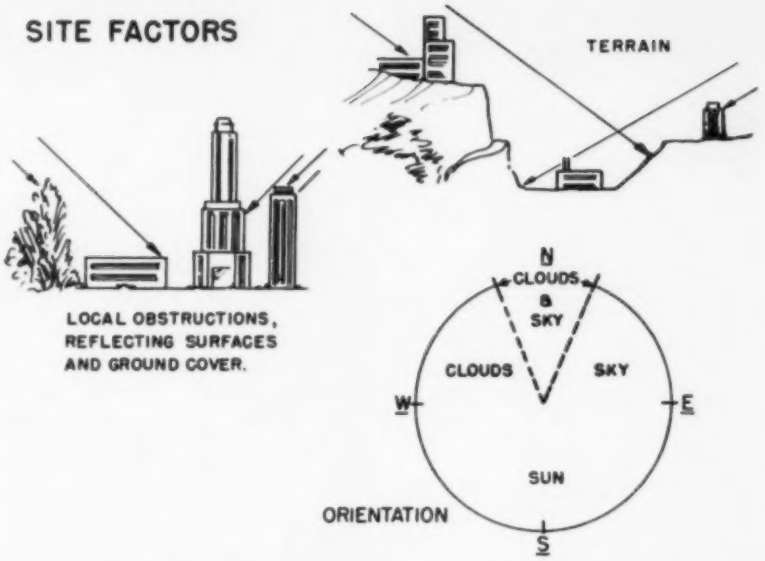


Figure 16. Site factors that influence the amount of daylighting that may be expected in offices include local obstructions, reflecting surfaces, ground cover, terrain and orientation.

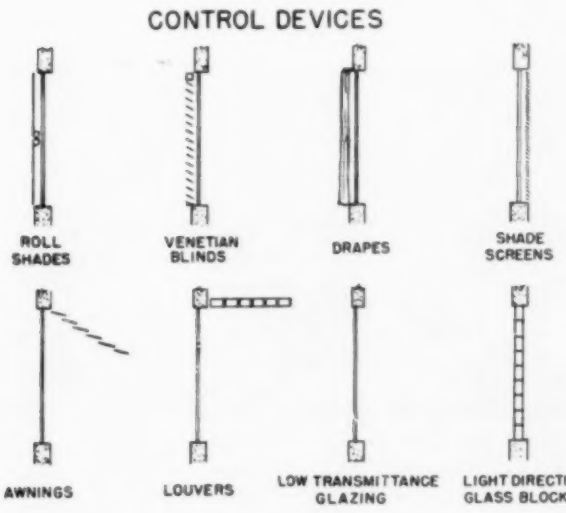
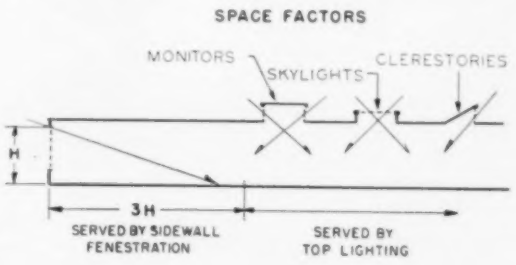


Figure 17 (left). Uncomfortable high brightnesses from daylighting may be prevented by any of several types of fenestration control devices.

Figure 18 (below). Space factors for daylighting.



(e) Except in the case of glazing media with integral controls that control brightness within comfortable limits, the fenestration plans should include provision for the use of supplementary roller shades, draw drapes, venetian blinds, louvers, shade screens or awnings (Fig. 17).

(f) With clear glazing, the upper portion of the window is most effective in lighting the deepest portions of a room. Thus the treatment of the window area nearest the ceiling is of great importance in producing useful levels in the rear of a room.

(g) When light-directing glass or glass block panels are used, they should begin approximately six feet above floor level. They are particularly effective in lower-ceilinged rooms, since the lower band of blocks near the six-foot sill delivers most of the light to the deeper portions of the room.

5.2 — *Electric Lighting Systems*

5.2.1 — *Types of Electric Lighting Systems*

5.2.1.1 — *General* — All interior lighting systems are included in one of the following five classifications. These comments refer specifically to applications in office areas.

5.2.1.2 — *Indirect* — **(a)** With this system, 90 to 100 per cent of the light from the luminaires is first directed to the ceiling and upper sidewalls from which it is reflected to all parts of the room (Fig. 19). The recommended high reflectance, matte room surface finishes are obviously essential to obtain reasonable utilization of the light, and these surfaces should be kept in good condition to maintain their high reflectances. Frequent cleaning of luminaires is important.

(b) The highly diffuse character of the light from indirect systems results in minimum shadows. Both direct and reflected glare are also minimized if the installations are well-planned. To this end it is desirable that the luminaire brightness approximate that of the ceiling, and the luminaire should be suspended a sufficient distance below the ceiling to prevent excessive ceiling brightness above the luminaires and to obtain as nearly as possible a uniform brightness distribution over the entire ceiling.

(c) Although indirect lighting systems providing illumination levels within the ranges recommended in Table III are usually comfortable, indirect lighting may be unsatisfactory at higher levels unless the installation is so designed that the ceiling brightness conforms with the limitations suggested in paragraph 3.2.2 (f).

5.2.1.3 — *Semi-Indirect* — **(a)** These systems emit 60 to 90 per cent of the luminaire output upward toward the ceiling and upper sidewalls while the rest is directed downward (Fig. 20). Since this type of lighting also utilizes the ceiling as the main source of light, the same considerations as for indirect

Figure 19. Indirect lighting; 90-100 per cent of the luminaire output is directed upward and 10-0 per cent is directed downward.

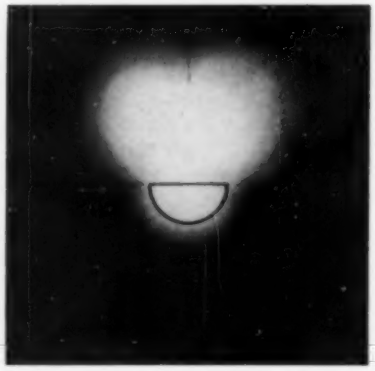
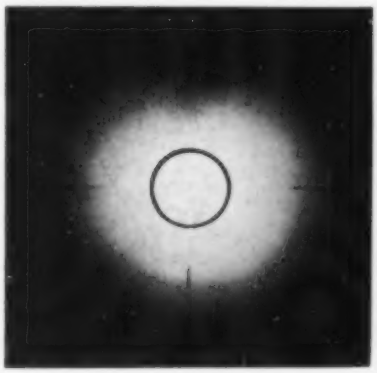


Figure 20. Semi-indirect lighting; 60-90 per cent of luminaire output is directed upward, and 40-10 per cent is directed downward.



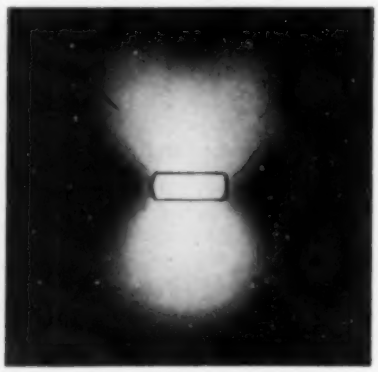


Figure 21. General diffuse lighting; 40-60 per cent of luminaire output directed upward or downward; (left) diffusing enclosure, (right) direct-indirect lighting.

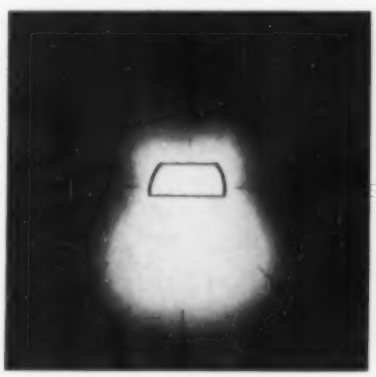


Figure 22. Semi-direct lighting; 60-90 per cent of luminaire output directed downward, 40-10 per cent upward.

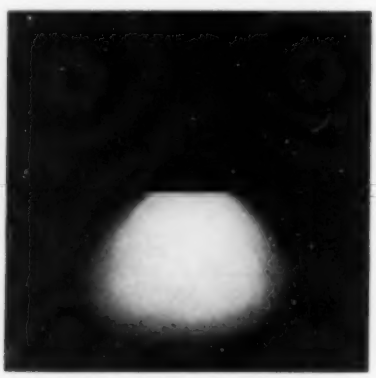


Figure 23. Direct lighting; 90-100 per cent of luminaire output is directed downward, 10-0 per cent upward.

lighting should be observed with regard to room finishes and good maintenance.

(b) In general, semi-indirect units are characterized by luminous surfaces which help achieve low brightness ratios between the ceiling and the luminaire, but as the downward component increases, the factors of direct and reflected glare may require attention.

(c) Because of the downward component, utilization with semi-indirect lighting is slightly higher than with indirect lighting. It is, therefore, possible to obtain somewhat higher illumination levels with fewer units and without excessive ceiling brightness.

5.2.1.4 — *General-Diffuse or Direct-Indirect* — **(a)** This classification refers to systems where the downward and upward components are about equal (each 40-60 per cent of total luminaire output) and the resulting illumination is predominantly from the downward component (Fig. 21). General diffuse luminaires distribute light about equally in all directions; direct-indirect luminaires emit very little light at angles near the horizontal. The latter are, therefore, generally more suitable since they are lower in brightness in the direct glare zone.

(b) With these systems, utilization is very good, but shadows may be more noticeable than with indirect and semi-indirect systems, and some discomfort may be experienced with direct glare from the general-diffuse types or some of the inadequately shielded direct-indirect luminaires. Since maximum brightnesses in the reflected glare zone will generally be lamp brightness or greater, care must be taken to employ high reflectance, matte finishes on all furniture and machine surfaces. Design for proper orientation as outlined in Section 3.2.3 (e) (3) should also be observed.

5.2.1.5 — *Semi-Direct* — **(a)** In this classification 60 to 90 per cent of the luminaire output is directed downward toward the work surface (Fig. 22). The smaller upward component illuminates the ceiling thereby increasing diffusion and reducing the brightness ratio between the luminaire and ceiling.

(b) As the downward component increases, more attention must be directed to minimizing shadows by designing the installations so that the light at any work point comes from many directions. The use of large area sources also helps to soften shadows. High reflectance, matte finishes on furniture and business machine surfaces are essential to minimize reflected glare. Careful orientation as outlined in Section 3.2.3 (e) (3) should also be observed insofar as possible.

(c) When general-diffuse or direct-indirect luminaires are mounted close to the ceiling, the distribution characteristics of the luminaires change to semi-direct. It should be recognized that the luminaire brightness will be increased when it is mounted close to the ceiling, and the brightness of the ceiling above the luminaires will often materially exceed the brightness of the luminaire. This is recognized in paragraph 3.2.2 (d) (5).

5.2.1.6 — *Direct* — **(a)** Units in this classification are defined as those which direct practically all (90 to 100 per cent) of the light downward (Fig. 23). The directional characteristics of this type of lighting may produce disturbing shadows unless the units are of large area or are closely spaced. Direct glare and excessive brightness ratios may be prevented by reducing the brightness exposed to normal view (Section 3.2.2) and by illuminating the ceiling through the use of high reflectance room and furniture surfaces (especially the floor and the desk tops) which will redirect a significant amount of light to the ceiling. The precautions outlined above for the prevention of reflected glare from semi-direct luminaires should be followed to an even greater degree with direct luminaires.

(b) *Area Lighting* extending essentially from wall to wall is also a form of direct lighting where light from sources in a large cavity of high reflectance is directed downward through cellular louvers or translucent or refracting glass or plastic. When these materials are used to completely conceal the lamps, the illumination characteristics of this form of lighting are similar to those obtained with indirect lighting systems. Baffles offer a means of improving comfort in large offices, and they may be of acoustic material. Reflected glare may also be a problem with area lighting systems employing cellular louvers as the shielding medium since specular surfaces at the working plane will pick up reflections of light sources that are visible when looking up into the cells.

(c) With luminous and louverall ceiling systems, more light should be provided around the perimeter of the room in order to obtain uniform illumination over the entire working area of the office. In practical applications this may be accomplished by:

(1) Adding another row of lamps (where rows are parallel with walls) and adjusting the spacing of the two or three adjacent rows slightly so as to gradually increase the lumen loading near the wall.

(2) Adding individual lamps between the ends of rows where the rows are installed perpendicular to a wall.

(3) Using lamps of higher lumen output at the sides and ends of rooms.

5.2.1.7 — *Summary* — **(a)** No one system can be recommended to the exclusion of all others, for each has characteristics that may or may not match the requirements of a given application. The performance of each should be evaluated first as to whether it will provide lighting for efficient, accurate seeing and a comfortable environment; secondly, the appearance of the equipment in the completed installation should be in keeping with the architectural and decorative design of the office.

(b) Indirect lighting systems are characterized by relatively low source brightnesses throughout both the direct and reflected glare zones, good diffusion and freedom from shadows, and low to moderate utilization. On the other hand, utilization is generally good with direct lighting, but the quality of lighting required for office tasks may be obtained only if precautions are taken to space the luminaires closely or use large area low brightness equipment. Intermediate systems combine the characteristics of indirect and direct lighting in varying degrees depending upon the predominant component.

6. Lighting and Seeing in Specific Areas

6.1 — *Private Offices*

(a) Private offices are usually of moderate or small size. Either direct or indirect lighting can be applied satisfactorily since much of the lighting equipment on the ceiling itself is gen-

Figure 24. This semi-indirect, large-size luminaire uses extra-high-output lamps to provide a maximum amount of illumination in the working area. The cornice lighting at the right was added to illuminate the walls for comfortable brightness ratios within the room.

Figure 25. Rectangular arrangement of troffers in this executive office is wired so that each side of rectangle can be switched separately to obtain any functional lighting pattern desired. Diffusing plastic ceiling enclosed by rectangle is transilluminated to a low brightness (about one-fifth that of troffer diffusing glass) to improve seeing comfort by eliminating large expanse of dark ceiling which would otherwise be present.

Figure 26. Plastic louverall "floating panel" ceiling provides the general room illumination in this private office. Valance lighting and portable table lamp have been added to give a residential atmosphere.

Figure 27. This installation of large area (four feet square) recessed luminaires with diffusing plastic shielding exemplifies the coordination of lighting and architecture in a group of modern executive offices.

Figure 28. In this installation, surface-mounted luminaires are arranged in a pattern over and around the work area to obtain maximum illumination on the task with minimum direct and reflected glare.

erally not within the visual field. Smaller rooms accentuate the inefficient utilization of indirect lighting. The arrangement and orientation of furniture in the private office is fixed and permits the placement of direct lighting equipment to minimize both direct and reflected glare. A lighting system may literally be designed for and around the office desk and furniture as illustrated in Figs. 24 through 30.

(b) Other factors of comfortable lighting must not be violated. Not only is it necessary to provide satisfactory illumination for the occupant at the point of work, but sufficient brightness on walls, floors and other areas is necessary to avoid high brightness ratios with the work. Some consideration should be given to others occasionally entering the office. The use of dark paneled walls, desks and floor coverings is not conducive to comfortable seeing and higher reflectance materials with equal decorative character are now available.

(c) The illumination required in private offices varies from that necessary for casual seeing during interviews to high values for prolonged study of reports, financial statements, plans and specifications. Where possible, the lighting system should be flexible to provide the order of illumination the varying tasks indicate. The higher values should be employed only when adequate provision is made for reduced brightness ratios between the lighting system and the environment, between the work and the environment, and among the environmental areas themselves.

Figure 29. The lighting system installed in this private office consists of two-lamp suspended luminaires with 45- by 45-degree shielding.

Figure 30. Light-colored room surfaces and a low-brightness, prismatic, plastic lens lighting system provide a comfortable environment for a private office.

Figure 31. In this semi-private office, parabolic aluminum troffers are combined with luminous panels. Almost 90 per cent of the room illumination is provided by the troffers.

6.2 — *General Offices*

(a) Most general offices are moderate to large-sized areas in which there may be many luminaires located directly in the field of view. In these areas, it is particularly important that the luminaire brightness limitations outlined in Section 3.2.2 be observed. At the same time, it is in the general office that seeing is most frequently difficult and most nearly continuous and, for this reason, quality and seeing comfort should never be compromised. The minimum quantity of light in use should be in keeping with recommendations in Table III. Details of visual tasks should be of reasonable size and have good contrast. Finishes, color and other environmental factors should be selected to assure full benefit from the lighting and to supplement all the advantages that can be realized in the tasks themselves.

(b) Since many office operations require more than one orientation of personnel, lighting and seeing should be comfortable for all directions of view. Changes in routine or personnel frequently require rearrangement of desk locations and partitions. General lighting installations originally designed to be comfortable from all directions need not be modified with changes in office procedure or organization. Where the existing system has a marked advantage of direct view comfort for one orientation of view, personnel should be oriented to take advantage of this situation.

(c) Since it is always possible that large offices may be subdivided in the future, every attempt should be made to arrange the pattern of light spacing in such a way as to facilitate subdivision rather than impede it. This requires close cooperation between the architect and the engineer responsible for the lighting layout to ensure that ceiling and lighting modules are compatible and suitable for possible subdivision.

(d) Care should be taken to provide the recommended quantity of illumination on the actual work surfaces. Most are horizontal, but some are vertical or sloping. Extra precautions should also be taken to insure proper distribution of light along the sides and ends of offices. Desks are frequently placed along walls where the

Figure 32. A high degree of diffusion with minimum direct and reflected glare is obtained with this semi-indirect lighting installation.

Figure 33. This banking office is characterized by an unusual and functional design of both the daylighting and electric lighting systems. A wall of light-directing glass block provides good general lighting, and recessed incandescent units and fluorescent troffers provide additional illumination on the work areas.

Figure 34. Two- by four-foot, three-lamp fluorescent troffers in this installation provide a maintained level of over 150 footcandles for regular office work which includes occasional blueprint work.

Figure 35. Adequate illumination and comfortable brightness relationships are maintained in this office by daylighting and electric lighting systems that use prismatic glass to control the light distribution.

Figure 36. High reflectance finishes throughout this large general office and a high level of general illumination from the luminous ceiling system provide a pleasant, comfortable environment with good seeing conditions. When viewed crosswise, acoustical baffles reduce ceiling brightness to an even lower value.

Figure 37. Troffers usually should be oriented for crosswise viewing as shown here. In this office, the light-colored, high reflectance floor redirects light back to the ceiling to minimize brightness difference between troffers and ceiling.

Figure 38. General lighting in this office area is from large area (4- by 4-foot) recessed fluorescent units.

Figure 39. Surface-mounted units are frequently used where ceiling heights are low and recessing undesirable.

Figure 40. The luminous ceiling in this general office uses decorative, formed, plastic panels as the diffusing medium. The lighted mural at right adds a decorative touch to the pleasant environment.

Figure 41. Baffles are frequently combined with luminous ceilings to provide sound conditioning, break the monotony of the over-all area lighting and reduce the total amount of luminous area in direct view.

Figure 42. Direct-indirect lighting from suspended fluorescent luminaires with louver bottoms and luminous sides is a popular method of lighting because it combines good diffusion and adequate shielding from direct glare with high utilization and reduced maintenance.

Figure 43. Continuous rows of two-lamp louvered, semi-direct luminaires, suspended eight inches from the ceiling, provide a maintained illumination level of 92 footcandles in this office. Additional illumination is provided by clear glass fenestration with venetian blind shielding.

Figure 44. "Floating panels" of plastic louver-diffuser material mounted below bare fluorescent lamps in drafting room. Boards are tilted nearly vertical to prevent reflected glare from bare lamps from being seen through louvers.

amount of light is inherently less if provisions have not been made to offset this reduction. This is generally accomplished by spacing luminaires more closely along the walls of an office area as recommended in Section 3.2.4. For desks in such positions, use wall reflectances in the upper part of the range in Table I.

6.3 — *Drafting Rooms*

6.3.1 — *General* — Drafting makes very serious demands upon the eyes and requires a high level of high quality illumination. Drafting involves accurate discrimination of fine details, frequently over long periods of time. The contrast between the work detail and its background may be very poor, as, for example, when tracing a faint blueprint or worn pencil drawing. Specular drawing surfaces, polished T-squares, plastic triangles, and scales are potential sources of reflected glare. Shadows along the drawing edge of the T-square or a triangle may materially reduce visibility; or strong, multiple shadows from the drawing instruments or the draftsman's hands may prove annoying.

6.3.2 — *Reflections* — On nearly horizontal boards, any ceiling or luminaire brightness may be reflected by the work to the eyes of the draftsman. Such reflections may sometimes be eliminated by proper positioning of the source or control of the direction of light flux with respect to the specular surfaces so that reflections will be directed away from the eye. It is usually more practical to minimize the effect of these reflections by controlling the brightness of the luminous area that is reflected to a low and fairly uniform value. This may be accomplished by employing lighting systems in which the lamps are completely concealed from the work. With the board in a nearly vertical position, specular reflections cause little if any trouble since they will be reflected toward the floor. See Fig. 45. Furthermore, the nearly vertical board may be high enough to shield the eyes of the draftsman from luminaire brightness otherwise in the field of view.

6.3.3 — *Shadows* — Where boards are near horizontal, edges of T-squares or triangles parallel to line sources having strong direct components may cast sharp line shadows (Fig. 46). Use of

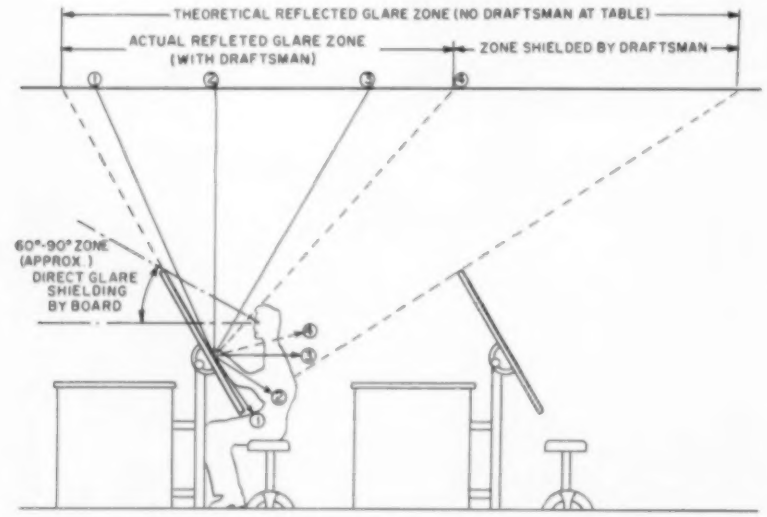


Figure 45. With drafting boards tilted in a nearly vertical position, as shown in drawing above, the specular reflections are reflected down toward the floor. The drafting boards may be high enough to shield the draftsmen's eyes from the luminaire brightness which, otherwise, would be in the field of view.

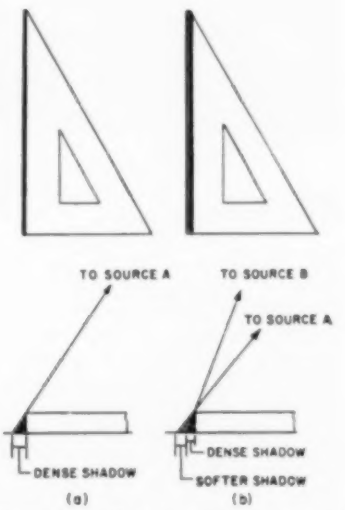


Figure 46. Shadow effects produced along edge of a triangle by one (a) and two (b) concentrated light sources. Shadow effect is reduced as number of source directions is increased.

Figure 47. Semi-indirect fluorescent lighting system in drafting room minimizes direct and reflected glare, T-square and triangle shadows. There is no limitation on placement of tables because of direction of light. This type of luminaire louvers the ceiling brightness when viewed from a crosswise direction.

Figure 48. The type of lighting in this drafting room is very similar to that shown in Fig. 47 above; however, lengthwise viewing direction is more comfortable with this type of luminaire, since there are no opaque side panels.

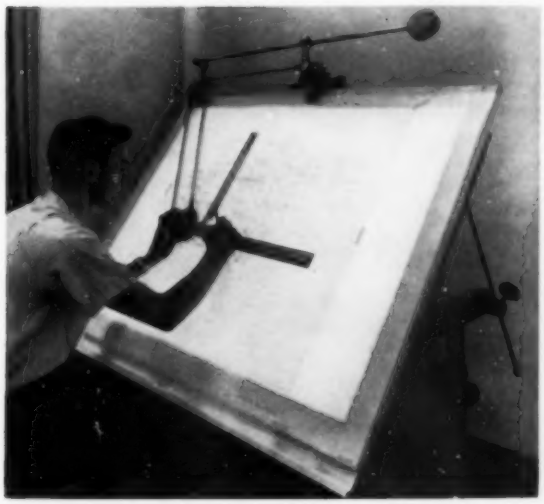


Figure 49. Transilluminated drafting table (left) provides high order of visibility for tracing drawings. Brightness of panel may be adjusted with dimming control located under lower edge of board. Transillumination (right) is by six 40-watt rapid-start lamps on dimmer control installed on six-inch centers in white cavity four-and-a-half inches deep. A piece of tempered glass is fitted to top of panel. A sheet of diffusing plastic covers entire panel, providing uniform brightness and a surface which will accept a compass point.

Figure 50. In this engineering-drafting office, where all draftsmen face the same direction, two-lamp channels without shielding were installed in front of steel shielding baffles to obtain comfortable illumination. Baffles form diagonal rows on five-foot centers, meeting at the center of the room. They have a white enamel finish on the lamp side, a buff finish on the viewing side to obtain the uniform brightness conditions shown (ceiling, 70 fL; baffles, 190 fL; side walls, 180 fL; front wall, 280 fL). Baffles are run at an angle of 17 degrees from a perpendicular line to the side walls to obtain best shielding and to prevent possible line shadows of sources running parallel to the working edges of triangles and straight edges. Photo at right shows the installation when it is viewed from the direction opposite to the normal direction of view.

indirect, semi-indirect, or other forms of over-all ceiling lighting will minimize such shadows. Where this type of lighting is not applicable or feasible, the frequency of occurrence of such shadows may be minimized by orienting either the luminaires or the drafting tables to create an angle of 15 to 20 degrees between the long axes of the luminaires and any of the major straight-edge positions (Fig. 50). Use of vertical drafting boards also virtually eliminates shadows on the task (Fig. 44).

6.3.4. — *Transillumination* — **(a)** A drafting table with a diffusing surface panel lighted from behind provides an efficient means of improving the visibility of tracing tasks. General room lighting should be used while tracing drawings since it also contributes to visibility and helps visual comfort by raising the surround brightness and reducing brightness ratios in the field of view.

(b) For tracing original drawings which have a relatively high transmittance (40 to 50 per cent) a luminous surface having a brightness of about 200 footlamberts provides excellent visibility. For tracing reproductions which are usually on heavier paper of lower transmittance (such as blueprints) 300 to 400 footlamberts is desirable. To avoid direct glare, the draftsman should use opaque paper to cover the portion of the glass which is not concealed by the drawing.

(c) The varying requirements for brightness suggest that the lamps be dimmer-controlled to permit selection of the optimum value for a specific task. In addition, it is desirable to keep the temperature of the tracing table as low as possible. Therefore, fluorescent lamps having a high luminous efficacy should be used. Simple ballasts and variable autotransformers are available for dimming 40-watt (48 inches long) and 30-watt (36 inches long) rapid-start fluorescent lamps. Twenty-watt fluorescent lamps (24 inches long) can also be dimmed when operated on trigger-start ballasts with a variable autotransformer in the primary of the ballast. (The dimming range and lamp life of these lamps may not be as good as with the rapid-start lamps).

6.4 — *Files*

(a) Files present the particular problem of work surfaces that are vertical, inclined and horizontal and frequently stacked one against the other. In order to provide the recommended values of illumination *on work surfaces other than horizontal,* it is generally true that considerably higher values will need to be developed on horizontal positions. In *active filing* areas, the work is likely to be of protracted nature and the visual task is of more than average severity. Where the room is primarily devoted to files, consideration should be given to luminaires designed and located to provide the recommended illumination level on vertical surfaces.

(b) Filing may involve correspondence which is frequently a carbon copy on low grade paper or may be cards and data sheets of various kinds with closely spaced figures and rules. While the majority of material in files is white, colored stock is often used for correspondence and certain card files. The type of stock being used should be investigated to make sure that no more than the necessary identifying tint is employed and that deep, saturated colors are avoided. There are certain modern filing systems which have "visible" indexes. These are frequently covered by transparent material which is shiny and picks up bright reflections. If the use of these materials is to be continued, the lighting units should be so installed that

reflected glare will be directed away from the worker's eyes. Where conditions do not permit these improvements, the use of large area low brightness lighting units such as shown in Fig. 53 is essential.

(c) Cabinet finishes of recommended reflectance will provide comfortable brightness ratios within the environmental areas of file rooms and will improve the seeing conditions at the point of work. Lighter finishes will reflect more light down between filed items which frequently are read without removal from the files.

6.5 — *Mail Rooms and Stock Rooms*

Rapid sorting and routing of incoming mail involves rather difficult seeing requiring the illumination level recommended in Table III. Pleasant, comfortable conditions should be provided through proper selection of lighting and control of environmental color and finishes.

6.6—*Conference and Board Rooms*

Effective coordination of good seeing conditions with the architectural and decorative designs of these rooms will result in comfortable and attractive areas. As in private offices, the use of these rooms varies considerably, but critical and prolonged seeing is encountered at times in most of them and the lighting level should be adequate for the most difficult, commonly occurring task. The illumination should be *designed* to *minimize* shadows on the faces of persons seated around the table. Undesirable reflections should be avoided. Moderately high reflectance matte finishes are recommended. Special attention to lighting of vertical surfaces is important if charts, displays or illustrations are frequently studied. Supplementary lighting is recommended for this purpose. Flexibility in providing light suited to varying use can be provided through suitable switching or dimming.

Figure 51. Troffer units provide a high level of illumination in this large centralized filing area. High reflectance floor helps to increase the vertical illumination on the lower filing rows.

6.7 — *Reception Rooms*

(a) Lighting for casual seeing fulfills the requirements of the usual reception room. Glare should be avoided to make the room pleasant in general appearance and to provide comfortable seeing for those visitors who choose to read while waiting. The choice of higher reflectance values for

Figure 52. Two-lamp fluorescent units with louver shielding give excellent vertical illumination on filed material in these high open-shelf files.

Figure 53. A large area, low brightness modular unit installed over these files minimizes the reflected glare which could occur in the plastic-covered file tabs.

Figure 54. Luminous ceiling in mail room provides comfortable seeing conditions and a pleasant environment.

Figure 55. Stock room is illuminated by direct-indirect louvered units installed between open stock shelving.

Figure 56. Standard fluorescent luminaires are arranged in an architecturally appropriate pattern for this conference room. A cove-like effect is obtained at the perimeter by suspending the luminaires on short stems and filling in the center of the rectangle with a false ceiling.

Figure 57. A combination incandescent system of cove lighting, recessed rectangular lens units, recessed baffle downlights and recessed louvered units provides an effective means of lighting this board room.

Figure 58. Standard lighting units fitted into patterns result in a distinctive appearance in this reception room. Plastic enclosed troffers form a large luminous element over the desk, while downlights provide fill-in illumination in the waiting area. Wall behind the desk is lighted with a recessed louvered element.

Figure 59. This reception area is lighted by a large "floating" luminous ceiling. The diffusing panels are arranged in an alternating pattern to add distinction to the installation.

Figure 60. Luminous ceiling installation in this telephone switchboard area provides general lighting without washing out signal lights or producing annoying bright specular reflections in the signal light cap.

Figure 61. Small reception room lighted by large area "floating panel" fluorescent luminaires. Illumination level is sufficient for regular office work, too.

Figure 62. Combination of fluorescent cove and incandescent downlights used in conjunction with decorative chandelier for general illumination in reception area.

room surfaces and furnishings will assist in making the room comfortable and seemingly more spacious.

(b) If a receptionist occupies the room, this person should be provided with lighting in keeping with the tasks assigned. Frequently, general office work is part of the assignment and the seeing requirements are more exacting than those for the casual occupant. Brightness ratios in the receptionist's visual field should be limited to low values and either a uniform amount of light should be provided throughout the room or more light provided at the work area, commensurate with the severity of the work assignments. The latter requires particular attention as to brightness patterns on walls, floors and desk tops.

(c) If a telephone switchboard with signal light indicators is present, it is important that the general lighting not "wash out" the signal lights (particularly if they are located on a horizontal plane). Care should also be taken to prevent reflections of bright light sources in the signal light caps.

6.8—*Stairways, Escalators, and Elevators*

The need for good lighting at these points is paramount in the interest of safety. Installations should be so designed that failure of one lamp will not leave an area inadequately lighted. Floor, wall and overhead finishes should be of high reflectance to gain the maximum utilization of the light and to reduce shadows.

6.8.1 — *Stairways* — **(a)** Stairway lighting equipment should be so located and shielded that persons neither cast shadows on the stairs nor encounter glare at eye level. A unit should be located at least on every landing and more closely if necessary.

(b) Special treatment may be necessary to call attention to changes in elevation in corridors where one or two steps are necessary. This may be accomplished by placement of small, shielded lighting units recessed near

Figure 63. Small elevator lobby lighted by large area fluorescent units (four feet square), one at each elevator and incandescent downlights (in background).

Figure 64. Fluorescent luminaires installed beneath wall railings produce maximum illumination on stairs. High reflectance steps, landings and walls reduce shadows.

Figure 65. The louverall ceiling in this elevator lobby provides uniform shadowless lighting throughout.

Figure 66. Elevator lobby with walls and floor lighted by ceiling-recessed incandescent units with black louvers.

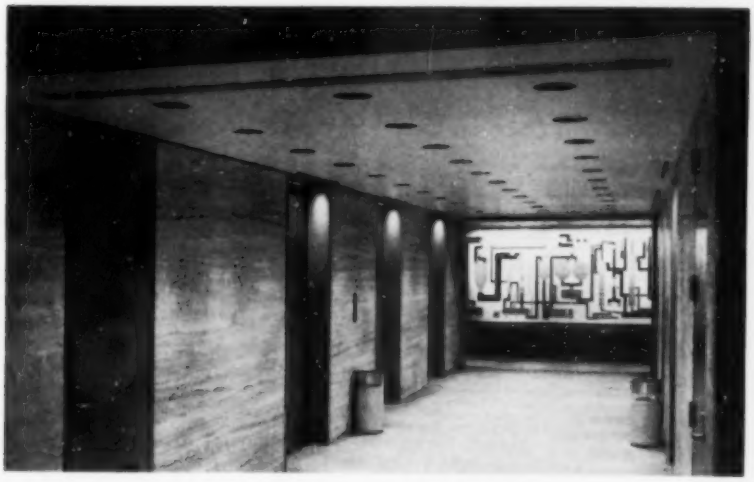


Figure 67. A low-ceiling elevator lobby is lighted by incandescent downlights. The close spacing of the luminaires provides even coverage on the floor and a high level of illumination.

Figure 68. This large elevator lobby has luminous ceiling elements along the walls for elevator threshold lighting; coffers in the center for general lighting.

Figure 69. In this wide corridor, lighting is provided by a combination of a fluorescent system (diffusing bottom troffers) and an incandescent system (downlights).

Figure 70. A luminous ceiling installation provides even illumination in this corridor. With the baffles running crosswise, as shown, the corridor is made to appear wider. Also, the illuminated plastic is shielded at the higher angles (from the vertical).

Figure 71. Two-foot square troffer units, evenly spaced down the length of this narrow corridor, provide an effective means of lighting, especially in combination with the high reflectance ceiling, walls and floor in the area.

the floor or by distinctive painting of the edges of the steps.

6.8.2 — *Elevators* — Good lighting of the threshold should be provided to call attention to any difference in level between the landing and the car. It is recommended that the car interior be of as light a finish as is consistent with reasonable ease of maintenance.

6.8.3 — *Escalators* — Good lighting should be provided on the tread, using shielded supplementary luminaires in the balustrade if necessary. Finishes should be of a light non-specular type.

6.9—*Corridors and Hallways*

The primary considerations in lighting corridors and hallways are safety, general appearance and brightness difference with adjacent offices. The spacing of lighting equipment from center to center should not exceed one and one-half times the mounting height. It is recommended that the amount of light in hallways be no less than 20 per cent of that in adjacent areas. Hallway illumination levels that are at least one-third of the levels in adjacent offices have been found to be preferable from the standpoint of relieving brightness differences between hallways and offices. The illumination values recommended for hallways should be provided at floor level. Reflectances for ceilings, walls, and floors should equal or exceed those recommended for the offices. If dark finishes must be used from the maintenance standpoint, they should be limited to the dado.

6.10—*Personal Service*

(a) Sanitary maintenance of restrooms and washrooms is considerably improved by sufficient illumination throughout the areas.

(b) When lounges are incorporated as part of washrooms, casual reading will require an illumination level in accordance with such tasks (see Table III). This may be provided by supplementary lighting if desired. Mirror lighting and similar residential treatments improve the appearance and usefulness of these rooms.

7. Other Considerations

7.1—*General*

There are certain specific considerations of importance in addition to the general factors of office seeing and lighting. These include the use of sup-

Figure 72. This corridor lighting installation consists of a continuous row of single-lamp fluorescent luminaires with wrap-around louvers that provide excellent endwise shielding, but do not obstruct the sideward light that illuminates the walls so uniformly. Satisfactory results could also be obtained with such equipment spaced intermittently down the corridor length.

Figure 73. Intermittently spaced two-lamp louvered troffers are employed to provide the excellent corridor lighting illustrated in the above photo. Special note should be taken of the fact that the luminaires are installed parallel to the length of the corridor. This orientation is usually preferable for all types of fluorescent luminaires installed in corridors.

Figure 74. Two rows of single-lamp fluorescent troffers illuminate the walls, the doors and the floor in this corridor. With the use of high reflectance surfaces as, for example, in this installation, light is reflected to the ceiling to reduce the brightness difference between the ceiling and the luminaires.

Figure 75. Surface-mounted units are used to illuminate this corridor. Luminaires are oriented crosswise to give the corridor a wider appearance. With this orientation, care should be taken in the selection of the luminaire as well as in the spacing in order to minimize the scalloping effect along the walls.

Figure 76. The general lighting in this small washroom is provided by fluorescent luminaires mounted along one wall at ceiling height. Fluorescent wall units, mounted vertically, at eye level, on each side of the wash basin mirrors, give supplementary illumination for grooming.

plementary lighting, the seeing requirements of business machine operations, and the need of rational maintenance methods and programs.

7.2 — *Supplementary Lighting*

(a) In some cases local lighting is used to supplement general illumination. Additional or supplementary lighting may be used advantageously in conjunction with general illumination to provide footcandle values which may be difficult to attain from general lighting or to compensate for losses due to the oblique position of the work (Fig. 79).

(b) Better posture and improvement in most seeing factors often result when office work is raised from the horizontal to some tilted or sloping position. A reduction in task brightness generally results since the illumination on horizontal planes is higher than that on planes more nearly vertical, but a net gain in visibility or ease of seeing is realized.

(c) Care should be exercised to choose supplementary lighting units which will distribute the light uniformly over the working surface without objectionable direct or reflected glare in the eyes of any worker in the office. Supplementary lighting should not produce brightness ratios within the field of vision beyond the one-to-one-third limit previously designated.

(d) Detailed discussion of supplementary lighting principles may be found in the I.E.S. "Recommended Practice for Supplementary Lighting."

7.3 — *Office Machines*

The tasks involved in the use of business machines may be divided into three classifications.

7.3.1 — *Seeing the Work* — Seeing the work consists of reading printed, typed or written figures and words and is facilitated by proper positioning of the work and/or use of supplementary lighting.

7.3.2 — *Operating the Machine* — Operating the machine involves the use of various keys, buttons, levers and other controls. It does not present a difficult seeing problem since most motions are performed by the touch system.

Figure 77. Parabolic aluminum troffers with cross louvers are used for general lighting in this lounge. Additional lighting at the vanity is from a continuous fluorescent wall unit mounted over the mirror.

Figure 78. Surface-mounted fluorescent luminaires equipped with cross louvers supply general illumination in this washroom. Mirror lighting is from a continuous fluorescent wall unit.

Figure 79. Supplementary lighting is often required for visual tasks of fine detail or poor contrast, viewed for prolonged periods, particularly if they are on near vertical surfaces.

7.3.3—*Reading the Dials and Tapes*—**(a)** Bold, block numerals are recommended for machine dials. Dials should be kept clean to maintain maximum visibility and wherever possible, it is desirable to avoid the use of transparent window coverings. Initially, these coverings are shiny and cause reflected glare and, in time, become scratched so that the visibility of the dials beneath them is reduced. It would insure more rapid and accurate work if lighting and magnification were incorporated in business machines as has been done for some industrial equipment and commercial scales. There is some advantage in viewing black figures which are on white dial backgrounds.

(b) Tape and other types of printing machines should be examined and properly maintained to get the greatest visibility possible. Type size should be large, but since it is usually fixed, full advantage should be taken of good white paper and solid, black impressions. Supplementary lighting, again, can often be used to advantage.

7.4 — *Maintenance*

(a) Good lighting maintenance is good economics; that is, good maintenance assures the user that he actually gets the light he pays for from the cost of electrical energy, luminaires and lamps. With a well-maintained lighting system, the user also gets the better seeing conditions that the system was designed to provide. In addition, all areas benefit from the more uniform appearance and fewer work interruptions that come with good maintenance. The new recommended lighting levels refer to the amount of light upon the task in service which makes it more important than ever to put good maintenance practices into effect.

(b) The elements which affect the over-all efficiency of a lighting system are the light sources, the luminaires and the room surfaces. Without a planned maintenance program, the illumination may be reduced to one-half its initial level due to decrease of the lumen output of the lamps, and dust and dirt on luminaires, lamps and room surfaces.

(c) The lumen output of electric light sources diminishes with use and, in most cases, it is economical to replace lamps before they finally fail. The lamps in a lighting system can be replaced individually as they burn out, or the entire installation can be replaced before the lamps reach their average life. Individual replacement is usually called "spot replacement"; mass replacement is called "group relamping." As labor cost of spot replacement increases, group relamping becomes a better course because labor costs are a larger proportion of the total maintenance cost. The cost of lamps is the smallest part of the lighting dollar. The labor costs saved by group relamping usually more than compensate for the value of the depreciated lamps that are thrown away before they burn out. Other advantages always accompany group relamping: more light, fewer work interruptions, better appearance of the lighting system, and less replacement of auxiliary equipment.

(d) A simple and economical method for replacing lamps is where group relamping is scheduled as follows:
(1) Group relamp every two years where fluorescent lamps are burned only one shift or 8 hours per day.
(2) Group relamp every 18 months where lamps are burned two shifts or 16 hours per day.
(3) Group relamp every year where lamps are burned three shifts or 24 hours per day.

(e) Lamps and luminaires collect dust which reduces the lumen output from the equipment. The rate of depreciation is dependent upon the amount of dust in the air and the type of luminaires employed. With regular cleaning schedules, an increase of at least 25 per cent is often realized in

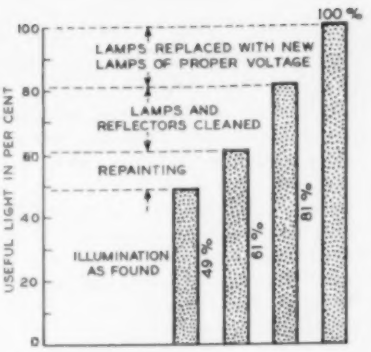


Figure 80. Increased reflectances, improved brightness ratios and higher illumination levels may be obtained by simple maintenance procedures.

the maintained value of illumination on the work plane.

(f) Some types of luminaires, particularly those of the indirect type, suffer to a greater degree from dust collection. In dusty locations, or where maintenance is difficult because of ceiling height, a luminaire having a construction least affected by dust should be used. Luminaires designed to permit air to pass over the reflecting surface should be considered for use in very dusty locations.

(g) The desirable frequency for repainting room surfaces is a function of the amount of dust present in the space. The rate of depreciation is materially reduced in air-conditioned office space where some of the dust is filtered out. The ceiling in work areas should be considered as an important element in the lighting system and should be given regular maintenance. The reflectance of the ceiling should be maintained at a high value to obtain the highest efficiency from the lighting equipment and to secure most comfortable seeing conditions.

(h) A regular schedule of window cleaning should be maintained. The diffusing effect of dust and dirt can result in very high brightness at the windows and can produce serious direct glare. In modern office buildings windows are cleaned about once a month.

(i) The cost of planned maintenance is more than offset by the increased efficiency of the lighting system and meeting the new recommended higher levels of illumination which are to be provided on the working surface. The investment in good lighting must be protected by proper maintenance.

Appendix A
Lighting Definitions and Nomenclature

A-1. — General

These brief descriptions and definitions have been extracted from the "Illuminating Engineering Nomenclature and Photometric Standards." Many popular concepts as to the meaning and significance of certain illuminating engineering nomenclature are erroneous and lead to misinterpretation and improper application of lighting principles.

A-2. — Light

For the purposes of illuminating engineering light is radiant energy evaluated according to its capacity to produce visual sensation.

A-3. — Lumen

The lumen is the unit of luminous flux (or time rate of flow of light).

A-4. — Reflectance

The reflectance (or reflection factor) of a body is the ratio of the light reflected by the body to the incident light.

A-5. — Transmittance

The transmittance (or transmission factor) of a body is the ratio of the light transmitted by the body to the incident light.

A-6. — Illumination

Illumination is the density of the luminous flux on a surface; it is the quotient of the flux (divided) by the area of the surface when the flux is uniform over the area.

A-7. — Footcandle

The footcandle is a unit of illumination. It is the illumination on a surface one square foot in area on which there is a uniformly distributed flux of one lumen, or the illumination produced at a surface all points of which are at a distance of one foot from a uniform point source of one candela.

A-8. — Brightness (Luminance)

Brightness is the luminous intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction.

A-9. — Footlambert

The footlambert is a unit of brightness (luminance) equal to one lumen per square foot and therefore is equal to the uniform brightness of a perfectly diffusing surface emitting or reflecting light at the rate of one lumen per square foot or to the average brightness of any surface emitting or reflecting light at that rate.

(The average brightness of any reflecting surface in footlamberts is, therefore, the product of the illumination in footcandles and the reflectance of the surface.)

A-10. — Luminaire

A luminaire is a complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

A-11. — Fenestration

Fenestration refers to any opening or arrangement of openings (normally filled with media for control) for the admission of daylight.

A-12. — Maintenance Factors

The ratio of the illumination on a given area after a period of time to the initial illumination on the same area is the maintenance factor. It provides a depreciation allowance for design purposes relating the initial illumination and the illumination at the time at which it is anticipated that maintenance procedures will be instituted.

A-13. — Coefficient of Utilization

The ratio of the lumens received on the work plane to the lumens emitted by the lamps is known as the coefficient of utilization.

Appendix B

B-1. — Economic Factors

B-1.1 — Cost — The over all cost or expense for the lighting would include: (a) an amortization of the first cost, or Capital Expense, (b) the cost of the electrical energy consumed, or Energy Expense, (c) the cost of the lamp replacements, or Lamp Renewal Expense, (d) an estimate for Cleaning Expense, and (e) an estimate for Repair Expense.

B-1.1.1 — *Form* — A form helpful in studying the expense analysis for one or more specific conditions can be found in the Third Edition, *IES Lighting Handbook*, page A-28.

B-1.1.2 — Determination of Factors for Form.

B-1.1.2.1 — *Installation Data* — The installation data is taken from the plan which is under consideration for a given room or building.

B-1.1.2.2 — *Capital Expense** — The complete cost of the installation (luminaires plus wiring) is obtained from a quoted price or a close estimate. The life of an installation is not fixed. In fact, because it may be desired to take advantage of future improvements in lighting equipment sooner than the installation might normally be discarded, it is customary to assume 8 to 10 years, and to divide the complete cost by this figure to determine the annual capital expense.

B.1.1.2.3—*Energy Expense*—The cost of electrical energy requires a knowledge of the local rate and an estimate of the hours the lighting is to be used as well as the total kilowatts for the area being lighted. Rates will vary with the geographical location and with the amount of use of energy. Multiplying the kilowatts by the hours by the rate will give the total expense for electrical energy.

B-1.1.2.4—*Lamp Renewal Expense*—Lamp manufacturers publish the rated average life of their lamps. Multiplying the number of lamps by the average hours used and dividing by the rated life* will give the number of lamp replacements for the period under consideration. This multiplied by the net cost per lamp plus labor cost will give expense for lamp replacements for the period.

B-1.1.2.5 — *Cleaning and Repair Expense* — The procedure for estimating the cleaning and repair expense, where these values are used separately and not as a part of the overhead, is indicated in the form.

B-1.1.2.6 — *Total Expense* — Adding these several elements will give complete lighting expense for period assumed.

*An item listed as "Overhead Expense" is sometimes used including what is here shown as "Capital Expense," plus "Cleaning and Repair Expense." This may be found by adding to the Capital Expense, as here determined, interest on the complete cost at one-half of the probable annual rate because of the decreasing principal and an estimated amount of perhaps 5 per cent of complete cost to cover cleaning and repairs. This method is used for a quick estimate or where there are not sufficient data for the longer method.

Appendix C — Wiring

C-1. — General

Adequate wiring is essential to good lighting. The wiring should have sufficient capacity to minimize voltage drop and energy loss. It must also be safe. These factors should be considered not only for immediate conditions but also for future demands.

C-2. — Reference

Suggested references on wiring are:

C-2.1 — National Electric Code
National Board of Fire Underwriters
85 John Street, New York City
222 West Adams Street
Chicago, Illinois
Merchants Exchange Bldg.
San Francisco, California

C-2.2 — Interior Wiring Design for Commercial Buildings
The American Institute of Electrical Engineers
33 West 39th Street
New York 18, New York

*Or the useful life if a group replacement plan is used.

New Levels and Scissors Curve Highlight Revised Office Practice

By C. L. CROUCH

APPLICATION of the Blackwell method of evaluation to office tasks has resulted in illumination values considerably higher than recommendations given in the previous (1956) "Recommended Practice for Office Lighting." Evaluation of actual tasks emphasized that the contrast of many office details is relatively poor.

In earlier Practices, emphasis was primarily on size, and considerable space was devoted to discussion of type sizes. However, measurements with Dr. Blackwell's Visual Task Evaluator (contrast threshold meter) indicated that for black-on-white printing, even small sizes of type (6-point) require very little illumination. It is when detail is no longer black, but grey or colored, such as in carbon copies, pencil handwriting, duplicated materials, bookkeeping and drafting, that much more light is needed. Everyone knows, from his own experience, that hard-pencil-writing is difficult to see and a fourth or fifth carbon copy is, at times, almost impossible to read. Fig. 1 illustrates a range of contrasts found in a typical group of office tasks.

AUTHOR: Technical Director, Illuminating Engineering Society, New York, N. Y.

The new Recommended Practice calls for the following footcandle recommendations:

Type of Office or Work	Footcandles on Task*
Cartography, designing, detailed drafting	200
Accounting, auditing, tabulating, bookkeeping, business machine operation, reading poor reproductions, rough layout drafting	150
Regular office work, reading good reproductions, reading or transcribing handwriting in hard pencil or on poor paper. Active filing, index references, mail sorting and critical visual tasks in conference rooms	100
Reading or transcribing handwriting in ink or medium pencil on good quality paper, intermittent filing	70
Reading high-contrast or well-printed material, tasks and areas not involving critical or prolonged seeing, such as conferring, interviewing, inactive filing and washrooms	30

*Minimum on task at any time.

For visualizing these recommendations, a series of illustrative tasks are presented (Figs. 2 through 6) for each of the categories.

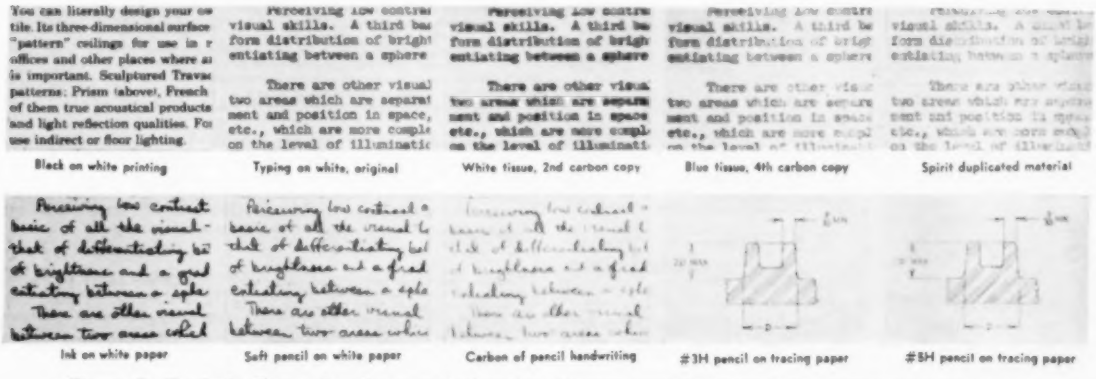

Black on white printing
Typing on white, original
White tissue, 2nd carbon copy
Blue tissue, 4th carbon copy
Spirit duplicated material
Ink on white paper
Soft pencil on white paper
Carbon of pencil handwriting
#3H pencil on tracing paper
#5H pencil on tracing paper

Figure 1. Typical office tasks photographed under the same conditions to show a range of contrast.

Designing and Detailed Drafting

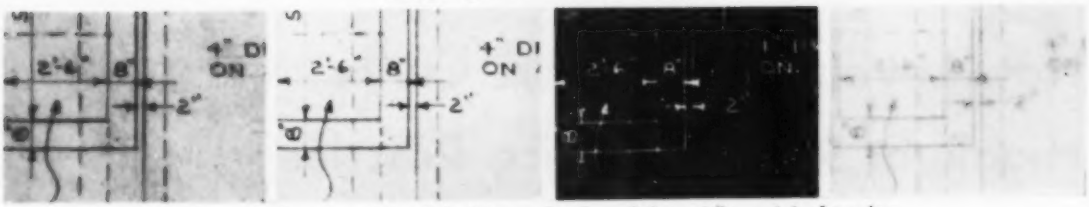


Figure 2. Samples of detail drafting tasks, from left to right: original tracing, black and white print, blueprint, original with tracing paper overlay.

Accounting, Auditing, Tabulating, Bookkeeping, Poor Reproductions, Rough Layout Drafting

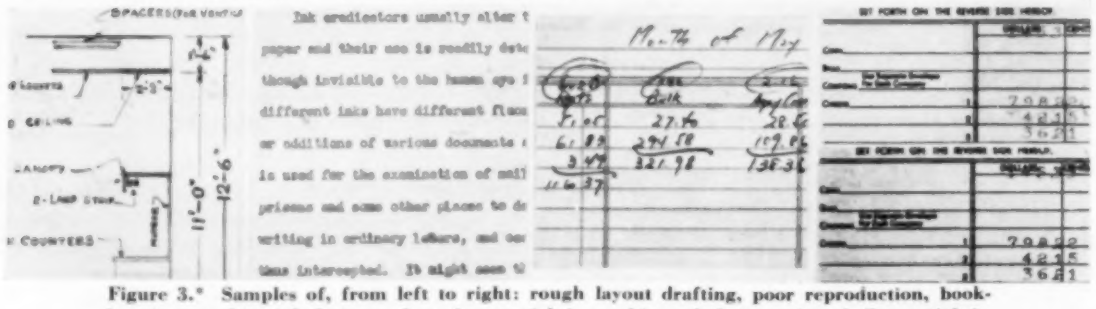


Figure 3.* Samples of, from left to right: rough layout drafting, poor reproduction, bookkeeping, machine tabulating carbon, (upper right), machine tabulating original (lower right).

Good Reproductions, Handwriting in Hard Pencil or on Poor Paper, Mail Sorting

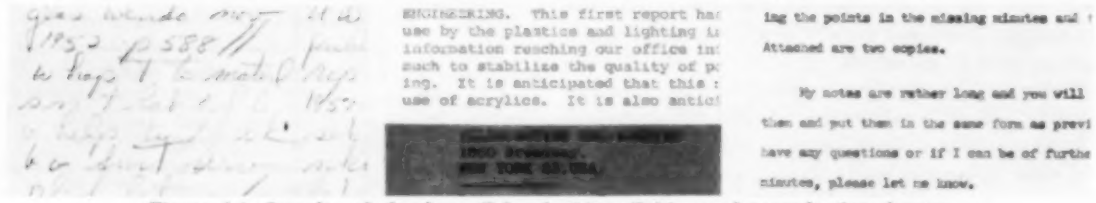


Figure 4.* Samples of: hard-pencil handwriting (left), good reproduction (center above), printed address on Manila paper (center below), typed second carbon (right).

Ink or Medium Pencil Writing on Good Quality Paper

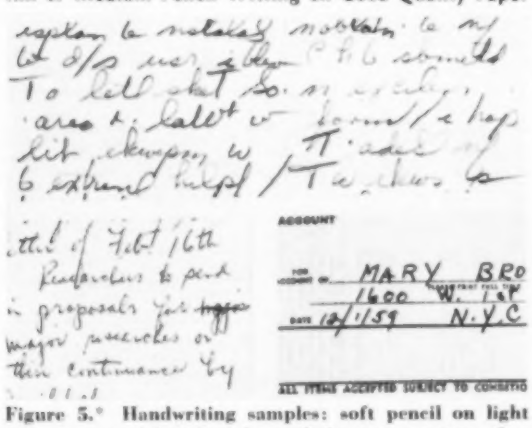


Figure 5.* Handwriting samples: soft pencil on light green paper (above), ink on light green paper, fine point (lower left), ink on yellow paper, broad point (lower right).

High Contrast or Well Printed Material

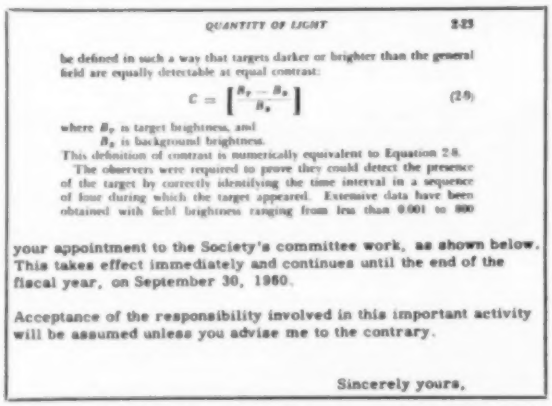


Figure 6. Samples of high contrast or well printed material: paragraphs from page of *IES Lighting Handbook* (above), printed letter (below).

*These tasks were all photographed and printed under the same controlled conditions.

Scissors Curve

The "scissors curve" (Fig. 7) takes its name from the crossing of two limiting curves at a juncture near the one end. This juncture serves as a fulcrum point through which a number of slant lines can be drawn to represent the limits of brightness distributions of particular luminaires. The location of the juncture and the possible series of slant lines below the main slant line make it look like a scissors, as the upper blade moves down toward the lower one.

It is common practice for testing laboratories to show average brightness curves of a luminaire, both crosswise and lengthwise, on their test reports (see Fig. 8). In order to see if a particular luminaire meets the brightness limitations of the scissors curve, the values given on the test report are plotted on the scissors graph, Fig. 7. (This is shown here in large size so it can be used immediately from this publication.) To illustrate how the curve is used, the data from Fig. 8 have been plotted on the scissors graph (Fig. 7) with the results shown in Fig. 9. Another example of this is shown in Figs. 10 and 11.

A further step is to check that maximum brightness values at any angle do not exceed the recommended ratio above the average brightness curve of

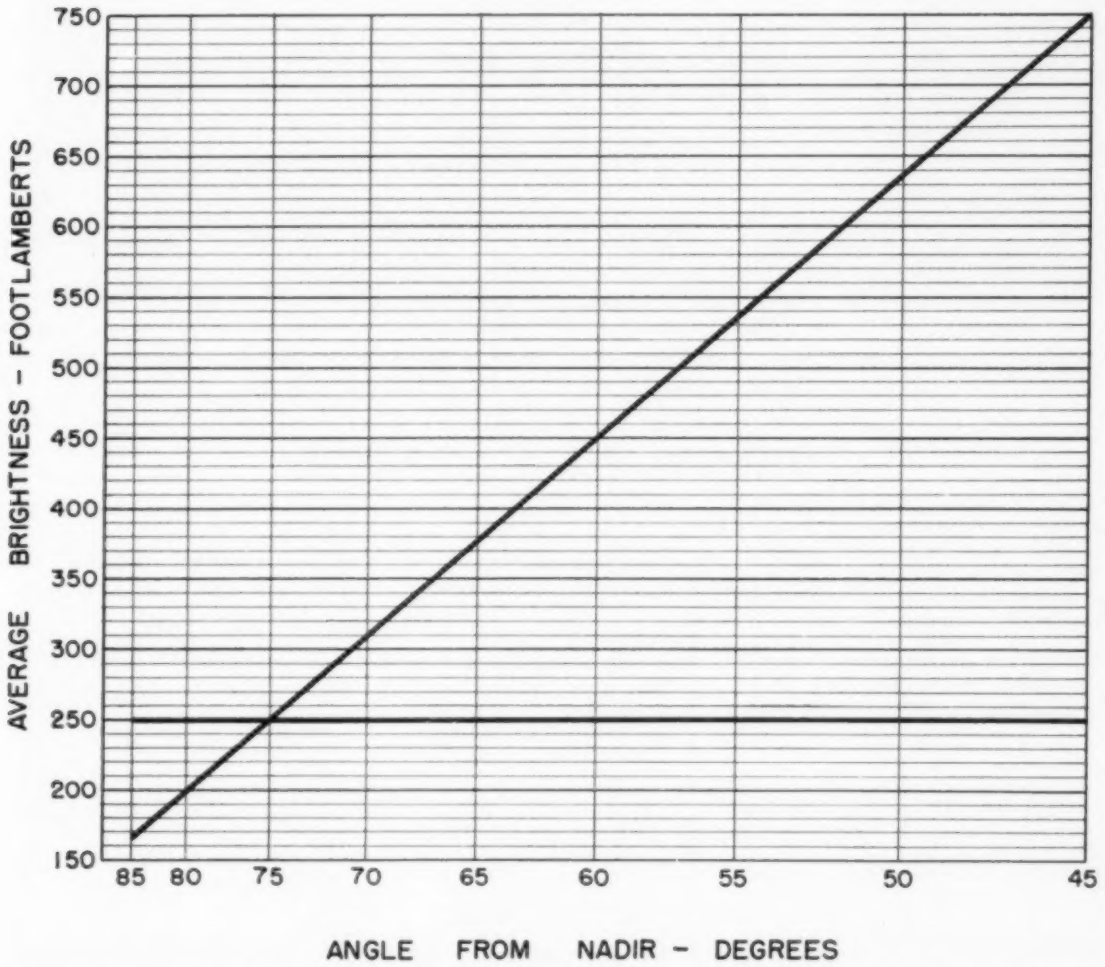
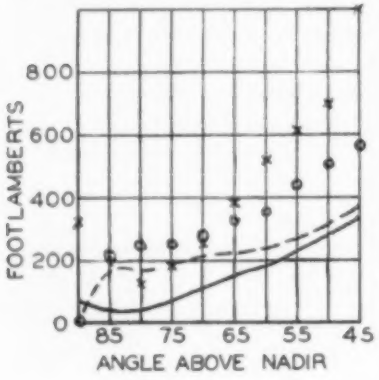
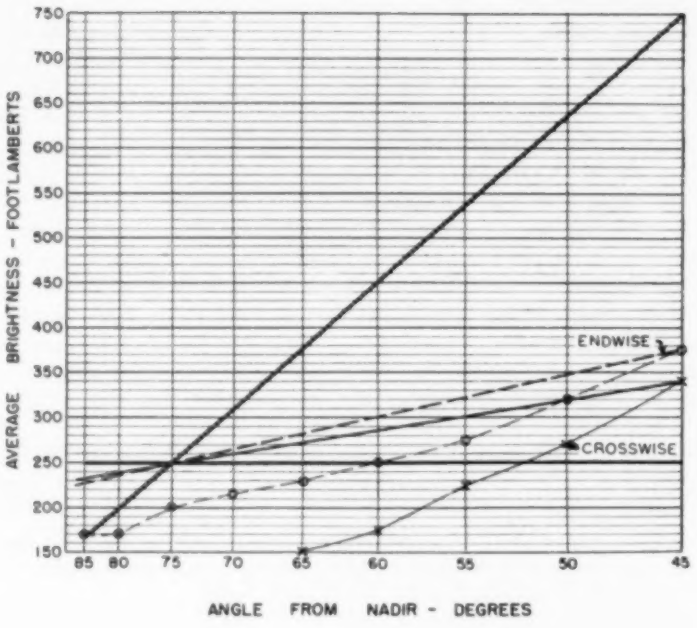


Figure 7. Direct glare limiting brightness guide—the "Scissors Curve." Direct glare should not be a problem in 30- to 100-footcandle fluorescent lighting installations if the ceiling and wall reflectances comply with those specified in Table I of the "Recommended Practice for Office Lighting," and if the luminaires used have crosswise and endwise brightness distributions which fall entirely below any straight line which is drawn through 250 footlamberts at 75 degrees lying between the above two limiting curves. The crosswise and endwise brightness distributions of the luminaire need not fall below the same limiting guide line.

Figure 8 (below). Typical testing laboratory report showing average (curves) and maximum (points) brightness data. Circles and dashed line are endwise values, "X's" and solid line are crosswise values.

Figure 9 (right). Plot of Fig. 8 data on "scissors curve." Luminaire meets brightness limitations of "scissors curve" both endwise and crosswise.

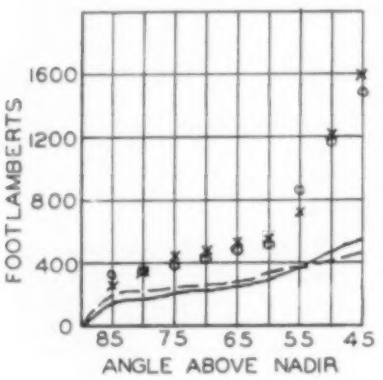


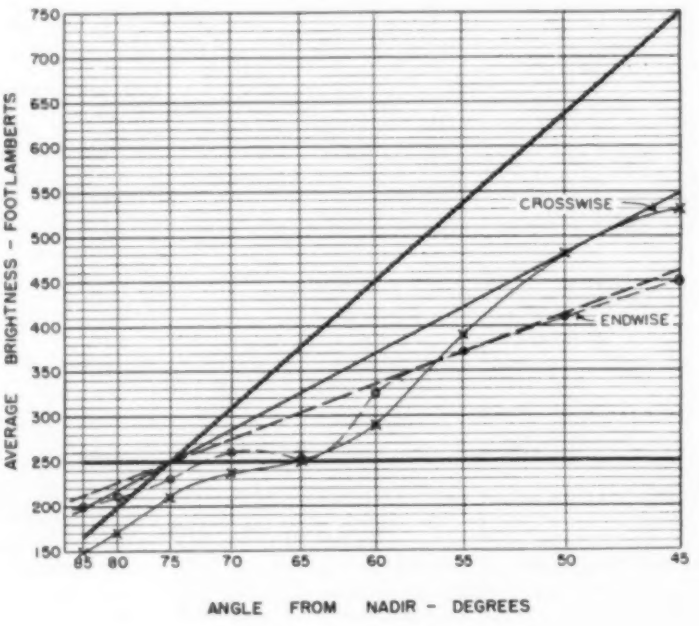


the luminaire. Here again, by looking at Fig. 8, one can see individual plotted points representing the maximum brightness at these angles. For the angle of 55 degrees (in Fig. 8), maximum crosswise brightness is 610 footlamberts. Preferably, the ratio should not exceed 3 to 1, but in no case should it be greater than 5 to 1. In the example shown, the actual ratio is 2.65 to 1, satisfying the 3 to 1 recommended ratio. The luminaire, therefore, passes all the provisions of the brightness limitations specified in the IES Recommended Practice for Office Lighting.

Figure 10 (below). Another example of laboratory report showing average (curves) and maximum (points) brightness data. "X's" and solid line are crosswise values; circles and dashed line are endwise values.

Figure 11 (right). "Scissors curve" plot of data in Fig. 10. Here again, luminaire meets brightness limitations.





INSTALLATION AT CARL SANDBURG JUNIOR HIGH SCHOOL, LEVITTOWN, PA.

Lighting a Gymnasium

LIGHTING OBJECTIVE: To provide illumination for high school basketball, for players and spectators, and for general exercising and recreation.

GENERAL INFORMATION: This gymnasium is 75 feet by 100 feet with a curved ceiling which is 18 feet high at the walls and 27 feet high at the center. A sliding partition is used to divide this modern interior in half for two separate recreation areas. Colors and reflectances of the major room surfaces are:

ceiling	gray plaster	60% RF
walls, upper	yellow cinder block	71% RF
lower	tan glazed brick	35% RF
floor	maple hardwood	35% RF
basketball backboard	white	80% RF

INSTALLATION: An average level of 50 footcandles (initial) was provided by 28 Holophane Co., Inc., catalog No. 635-AL luminaires with prismatic glass reflectors and spun-on aluminum covers. Each unit has provisions for a nine per cent upward component of light and is equipped with a 400-watt H1LB improved-color mercury lamp. They are installed above the ceiling in Plexiglas domes projecting above the roof line, as shown in Fig. 2, on 12-foot by 16-foot 9-inch spacing.

Brightnesses were: ceiling, 4.6 fL; upper walls, 11.5 fL; lower walls, 6.2 fL; floor, 14.5 fL;

(over)

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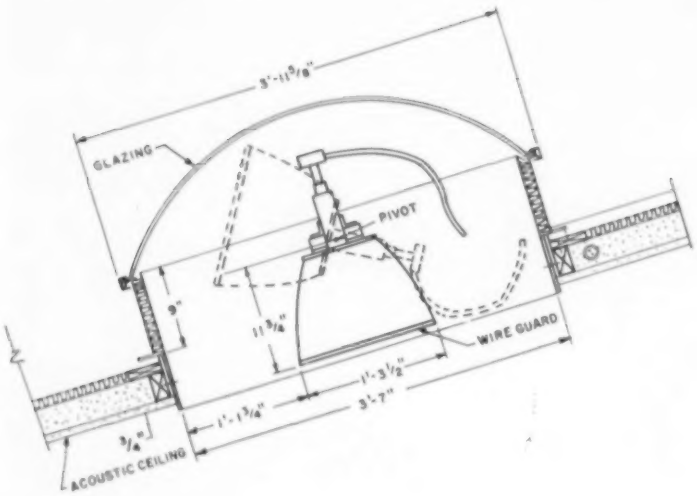

Figure 2. Detail of sky dome.

basketball backboards, 18 fL; partition ceiling track, 4.6 fL; and aluminum band on luminaire dome, 14.5 fL.

Luminaire maintenance can be performed from the roof by turning the unit as shown in Fig. 2. During the day the plastic domes admit daylight to provide some general illumination. At night, when the gymnasium is illuminated, the lighted domes provide an interesting effect from the outside.

Lighting designed by Haag and d'Entremont, Architects, Jenkintown, Pa.; John Knecht, Consulting Engineer, Collingswood, N. J.; Peter Lowenthal, Electrical Contractor, Philadelphia, Pa.

Lighting data submitted by Carl Gershanick, District Manager, Holophane Co., Inc., Abington, Pa. and by George T. Anderson, Jr., Philadelphia Electric Co., Philadelphia, Pa., as an illustration of good lighting practice and to aid in the design of similar installations.

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Combined Light and Air Solution At Harris Trust

By WILBUR C. JOHNSON
BENJAMIN S. BENSON, JR.
ROBERT S. GEOCARIS

Lighting and air conditioning, combined in one unit designed for a five-foot module, permits flexibility in partition arrangement, operates efficiently and economically in new office building of Chicago's Harris Trust and Savings Bank.

LATEST growth plans of the Harris Trust and Savings Bank in Chicago feature a recently completed addition to the bank building. This 23-story expansion, offering well over a quarter million square feet of additional floor space, adjoins the parent building and presents a modern, harmonizing appearance when viewed against its predecessor.

In planning the building, the architects selected a five- by five-foot module as the most workable solution for all design and installation elements. Partions capable of being located at the junction of each module provide a high degree of flexibility in office size and arrangement to suit the needs of both the bank and the tenants. Since there was to be no static office arrangement, it was necessary to find some means of providing both lighting and air conditioning which would operate satisfactorily without regard to partition location, and would require a minimum of changeover to meet any revised demands.

Studies indicated that the most desirable solution was for each five-foot module to have its own lighting unit and the potential to supply or exhaust air, as required. To provide each of these services separately, in each five-foot module, was cumbersome and costly, but their combination, by means of a recessed troffer as both the light and low velocity air diffuser, offered many proven advantages. In addition to eliminating much of the visible "hardware," the combination effectively integrated requirements of both electrical and mechanical devices. Inspection of installations of similar equipment after several years of service indicated that ceilings remain cleaner with this system than with air diffusers delivering higher air velocities. Use of a greater number of air diffusers, each delivering a smaller air volume straight down like gentle rainfall, made partition locations relatively unimportant, as no air "bounce" occurred to create a draft condition.

The air-handling troffer selected (see cross sec-

AUTHORS: Chief Electrical Engineer, Skidmore, Owings and Merrill, Chicago, Ill., Director of Research and Development, and Merchandising Manager, both of Thomas Industries, Inc., Benjamin Division, Des Plaines, Ill.

Installation Steps

1

Electrician attaching wiring channel to end of troffer prior to installation in ceiling.

2

Electricians "laying" troffer into five- by five-foot ceiling module and connecting wiring.

3

View of one floor, typical of 21 in the building. Troffers are held in proper alignment by positioning clamps attached to the ceiling.

4

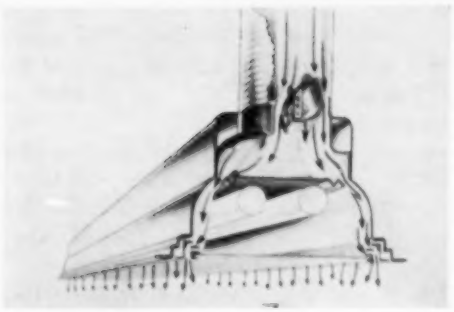
Sheet metal worker "threading" air volume control valve onto five-inch diameter flexible air duct. Air deflection vanes on both sides of valve assure uniform distribution of air throughout troffer housing.

5

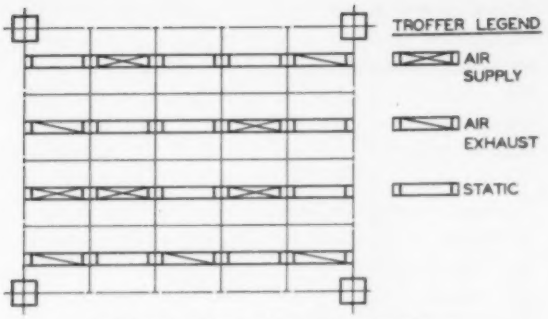
Sheet metal worker placing the air valve into its proper position in the troffer housing.

6

"Threading" of five-inch duct collar to flexible air duct completed, snap-in flange is pushed into five-inch diameter cutout in the side of rigid air duct.



Cross section of troffer.



Reflected ceiling plan of "typical" bay.

tion) provided for the operation of two 40-watt rapid-start fluorescent lamps over either a high light transmission opal or low brightness prismatic glass, depending upon location. A large knock-out in the top of the troffer permits the unit to be operated as a non-air-handling device for those locations where this was desired. With the unit acting as an air supply, this knockout was removed and a balancing valve inserted, with a flexible air hose connected to the metal supply duct. For exhaust, the troffer was connected in similar fashion to the corresponding duct. By these means, the same basic troffer could act in all three capacities with a minimum of effort required if future office revision called for a change in the location or number of air diffusers.

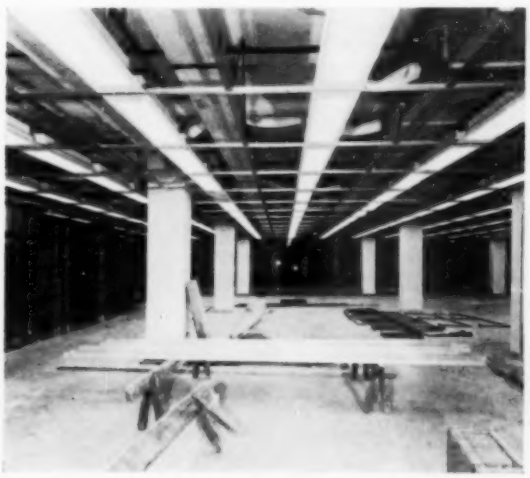
The nominally 12- by 48-inch troffer was redesigned, at the architect's request, to fill out the five-foot module length and rest at each end on the T-grid of the ceiling framework. The troffer provides fourth-side support to the white matte finished Fiberglas lay-in panels which close off the ceiling. Rectangular wireways, off center to avoid the support for the ceiling framework, provide a grounded wireway between adjacent units in each continuous run.

While the exact illumination values in the building vary with the reflectances and proportions of each area, the lighting system is designed for 65 footcandles, maintained (70 per cent maintenance factor) in the open areas of the office floors. Architect's recommendation for troffer cleaning is twice yearly.

Light and power distribution was designed with a 480-volt three-phase primary with 120/208-volt transformation on each floor for lighting.

Drawing above shows a "typical" 20- by 25-foot bay with supply, exhaust and static troffers indicated for a particular set of air-handling requirements. Adjacent bays may have completely different sets of arrangements if conditions warrant.

The over-all air conditioning plan divides each



Excellent example of good architectural "module" design. Note that shallow plenum has not been crowded with unnecessary duct work.

Completed installation. After this photograph was taken modern furnishings with light surfaces were installed in the offices of the building.

floor into a perimeter zone of 20-foot-width adjacent to the external curtain walls, and an interior zone comprising the remainder of each floor area. The perimeter zone is air conditioned by induction units located under each window which provide both heating and cooling. The air troffers servicing the interior zone, while capable of providing both heating and cooling, generally will provide air at 56 degrees Fahrenheit (dry bulb). Both the supply and exhaust troffers handle air at 75 cubic feet per minute.

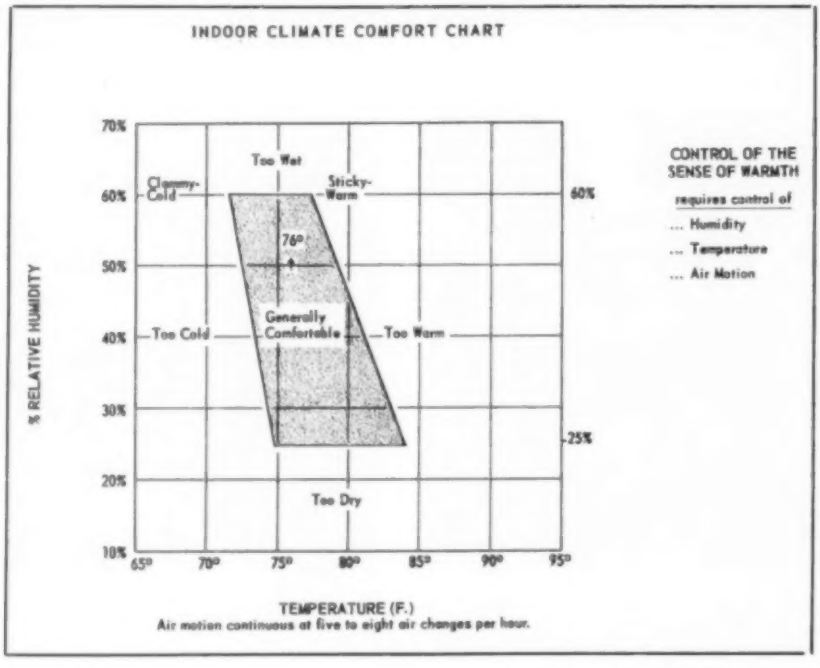
Air conditioning equipment is housed on the 11th floor of the building, with supply and return duct risers feeding up and down to all floors. High-pressure, high-velocity air is fed to the induction units serving the perimeter adjacent to large glass areas. Medium-pressure, medium velocity air is sent through pressure reducing valves on each floor, then through ten-foot sound-reducing chambers to the air troffers. The air cooling equipment is rated at 1200 tons and delivers a total of 324,000 cubic feet per minute to give approximately six air changes per hour.

Air cleaning is provided by a pre-filter (consisting of an automatic roll-type filter) followed by a dry-type unit filter using a renewable element. Required filter maintenance is expected to be very small, due to the use of the pre-filter.

Reports indicated that this combined lighting and air conditioning installation progressed smoothly, with no conflict among the trades involved. Cost savings realized should be considerable, although the total savings will depend upon the number of times partitions are changed. The installation has been rated quite satisfactory in meeting design expectations of both owner and architect.

Comfort Triplets of Air Conditioning . . . Temperature — Humidity — Air Motion

This chart is reprinted from an article on air conditioning comfort by Glydewell Burdick, Wisconsin Power and Light Co. (published by EEI). It was not intended to relate to *lighting* and air conditioning, but its simple graphic demonstration of temperature-humidity-air motion relationships is of interest in modern office design.



INSTALLATION AT BONAWITZ'S BARBER SHOP, 908 CUMBERLAND ST., LEBANON, PA.

Lighting a Barber Shop

LIGHTING OBJECTIVE: To provide a comfortable high level of illumination for hair cutting and a lower level of general illumination for reading in the waiting area.

GENERAL INFORMATION: This barber shop, which was converted from a storeroom, is 20 feet by 30 feet and accomodates five barber chairs. A longitudinal ceiling beam 12 inches wide by 18 inches deep was coordinated with the lighting design to divide the shop into two parts—the working area and the waiting area, as shown in Fig. 2. The ceiling height in the waiting area is 12 feet 6 inches. In the working area the ceiling height has been lowered to 11 feet by the use of perforated acoustical tile and polystyrene ½-inch cube louvers.

Reflectances and colors of the major room surfaces are:

ceiling	white	85% RF	walls		
plenum	white	88% RF	plaster	willow green	25% RF
counters	white with		paneling	light walnut	13% RF
	metalic gold	25% RF	floor	light tan	14% RF

INSTALLATION: In the work area general lighting is provided by an 8-foot by 26-foot luminous area formed by the installation of Electro Lighting Corp. white Polycube polystyrene ½-inch cube louvers, with 45- by 45-degree shielding, below 26 fluorescent single-lamp channels on 12-inch centers. Each channel is equipped with one 96-inch T-12 deluxe cool white 800-ma rapid-start lamp.

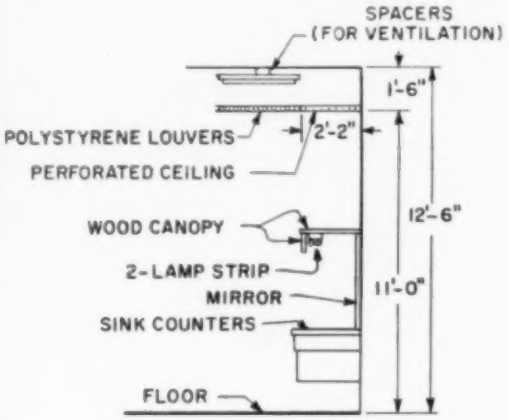
Supplementary lighting is provided over the sink counters by the installation of two-lamp channels in the wood canopy as shown in Fig. 3. (These channels are also equipped with deluxe cool white lamps.)

(over)

A.I.A. File No. 31*f*

Figure 2 (left). View showing the waiting area (background) and working area (foreground).

Figure 3 (below). Section through working area showing wood canopy over sink counters.



There are three Silvray Lighting, Inc. ILC semi-indirect luminaires, each equipped with two 96-inch T-12 deluxe cool white 800-ma rapid-start lamps, installed 11 feet from the floor on six-foot centers in the waiting area.

After 1600 hours of operation the illumination level was 238 footcandles at chair height in the working area. The average level of illumination in the waiting area was 85 footcandles, intentionally lower, to emphasize the business side. Brightness readings were:

plastic ceiling at 45 degrees	110 fL	walls	
floor	21 fL	plaster	24 fL
counters	42 fL	paneling	11 fL

Lighting designed by Frank E. Heins, Lighting Engineer, Metropolitan Edison Co., Reading, Pa. Installed by Heagy Electric Co., Lebanon, Pa.

Lighting data submitted by Frank E. Heins, Metropolitan Edison Co., Reading, Pa., as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Efficient use of office space means planned furniture arrangement often using perimeter wall areas for desk locations. With conventional spacing between fixtures and side walls, people at perimeter desks often get "second class" lighting with uncomfortable shadows, fixtures in field of view. But integration of the furniture and illumination designs using higher loaded lamps or more lamps in side wall fixtures can mean . . .

"First Class" Perimeter Lighting

By JAMES F. FINN

PLANNED furniture arrangement in general office areas should contribute, first of all, to the efficiency of office operation. Often, people are placed at desk locations which have been planned to a modular arrangement or positioned in groups determined by similarity of work duties. This policy arises from sound office management principles which require maximum use of office space, with a planned orientation of desks and files, to produce maximum personnel efficiency at the lowest possible cost.

Fig. 1 illustrates a furniture arrangement using perimeter wall areas—a modular design fitted to the needs of a particular management. Diversified office furniture modules are available in a broad range of sizes. Desk surfaces, work tables, credenzas and other equipment can be integrated into the module size as required.

Specification of office furniture and file equipment for general and private offices is no longer stereotyped in design and size; however, desks for general offices have an accepted size standard—five feet long, two feet six inches wide. Light-colored, flat desk surfaces are available in a variety of pastels; work tables and two-drawer files are designed to fit into a modular pattern.

Today's trend in office planning is not only to departmentalize but also to provide privacy through the use of portable five-foot six-inch high partitions. Planned perimeter lighting should be designed to use the space adjacent to wall areas for *any* furniture arrangement. In designing the lighting for any office layout or modular furniture arrangement, the orientation of desks should be planned so that office personnel face the least bright part of the lighting fixture. In most cases, this is the end of the fixture. Where it is desirable to install fixtures with the side view visible to office personnel, opaque metal panels or low brightness glass or plastic panels are recommended.

For many years, a common rule of thumb was to use one-half the distance between rows of luminaires for the spacing between the luminaire and the side wall, as shown in Fig. 2. Thus, if the luminaire row spacing was on ten-foot centers, five feet were specified as the spacing between the luminaires and the side wall. This spacing not only causes shadows on desks adjacent to walls, but results in a sharp drop in the illumination level on the work task (Fig. 3).

There are two alternatives for correcting this

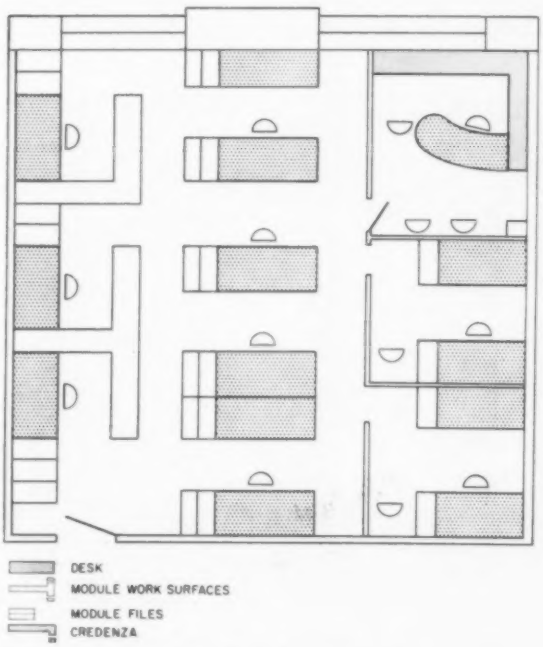


Figure 1. Reflected furniture plan.

AUTHOR: Commercial Lighting Coordinator, Detroit Edison Co., Detroit, Mich.

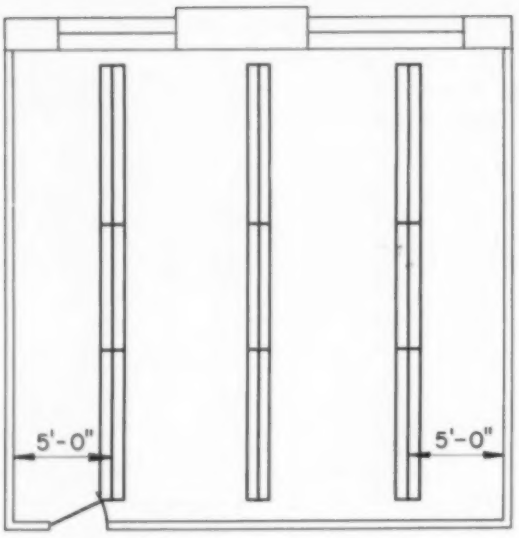


Figure 2. Conventional side wall spacing.

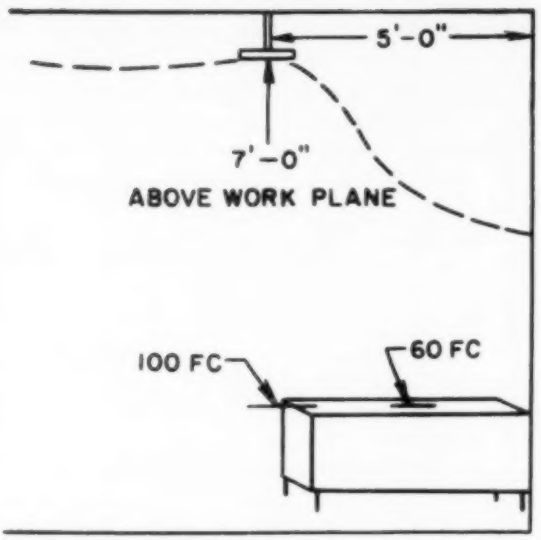


Figure 3. Luminaire distribution five feet from wall.

condition: (1) Move all desk equipment from the side walls to the center of the office which, unfortunately, creates a crowded environment and wasted space, or (2) relocate and add luminaires to permit maximum utilization of office space—the sounder and more effective solution, as shown by Fig. 4. This plan is particularly adaptable for installations of recessed, surface or pendant-suspended luminaires.

Spacing between luminaires and the wall should be two feet six inches to permit rearrangement of desks with maximum effectiveness of the lighting system. When a conventional desk (five by two-and-a-half feet) is placed against the wall, with the worker facing the wall, the luminaire spaced two feet six inches from the wall will be centered over the worker's edge of the desk. Thus, overhead luminaires will not be visible to the seated person. Luminaires spaced further than two feet six inches from the wall cause shadows on the work, since the light source is behind the seated worker.

Where the *end* of a desk is placed against a wall,

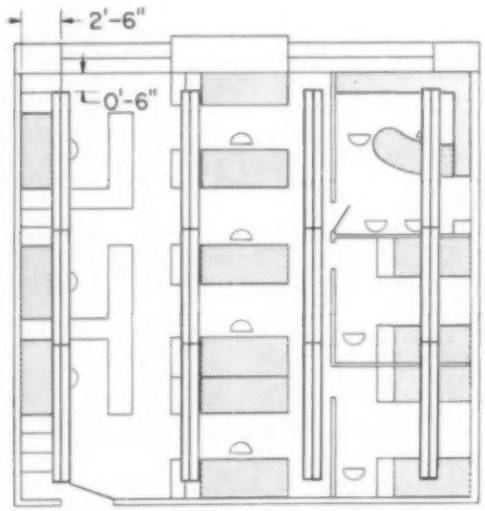


Figure 4. Spacing of luminaires two feet six inches from wall permits maximum orientation of office equipment.

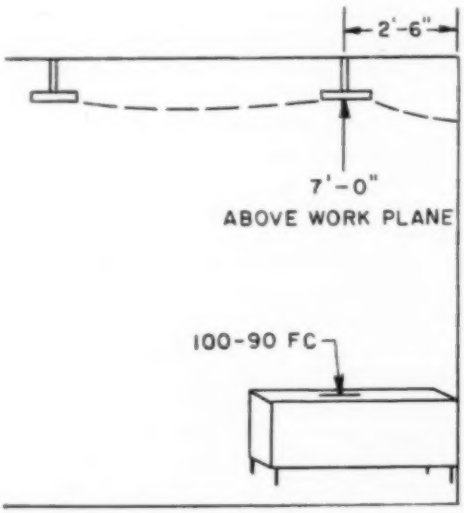


Figure 5. Luminaire distribution two feet six inches from wall.

a fixture spaced two feet six inches from the wall would also be centered over the desk. Endwise spacing of fixtures should be close to the wall to provide uniform lighting on desks and minimize shadows. This is accomplished by spacing the ends of fixtures very close to the wall, preferably six inches to a foot, but never more than two feet. Spacing closer than six inches may result in light scallops on the wall and/or prevent the removal of the lighting fixture end plate for servicing. The benefits of this spacing plan are shown in Fig. 5—higher illumination levels on the desk surface (and reduction of annoying shadows).

The efficiency of wall-to-wall and floating ceilings for room-wide lighting distributions is well-accepted. There are drawbacks to these systems, however, as well as to systems using recessed, surface and pendant-suspended luminaires, despite the recommended practice of spacing from side and end walls.

Perimeter side walls may have a reflection factor of less than 50 per cent resulting in a lower lighting level at desks adjacent to side wall, because of the absorption of light by these walls. A proposed solution to this inadequacy at perimeter locations is to increase the *loading* of lamps or increase the *number* of lamps in conventional luminaires or the modules in wall-to-wall or floating ceilings which parallel perimeter side walls (see Figs. 6 and 7).

Since workers at perimeter desks need the same illumination levels as those in the center of the office area, it becomes the responsibility of the manufacturer to design perimeter luminaires (recessed, surface and pendant-suspended) to accomodate more lamps per luminaire or higher loaded lamps (such as the 800- or 1500-ma), yet maintain the same size and appearance as the general luminaire. In wall-to-wall or floating ceilings, the addition of lamps in perimeter panels should be specified by the designer and engineer.

New designs in many forms and sizes of office equipment are planned in modular arrangements along perimeter walls, as well as in the center of offices. A lighting system designed to produce the proper quantity and quality of illumination for office tasks, coordinated with the environmental effect produced by new designs in furniture and modules, should be the responsibility of the lighting engineer.

Private office lighting is planned not only to give sufficient light for prolonged seeing tasks but also for environmental effect. Lighting for private offices permits a pleasing integration of fluorescent and incandescent sources, the effect desired dependent upon the decor. Incandescent downlights

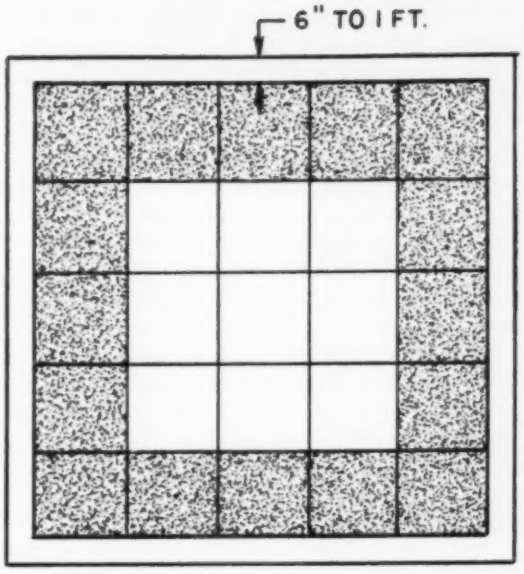


Figure 6. Wall perimeters of floating ceilings require additional lamps.

can be used to create atmospheric effects for accessories and casual seating areas. Draped windows should be lighted. Portable lamps provide another means of giving individuality to a lighting design.

Planned orientation or any rearrangement of office furniture must be integrated with the lighting layout. Maximum lighting efficiency for perimeter wall areas, in any suitable furniture arrangement, can be assured by the use of higher-loaded lamps or more lamps in perimeter fixtures.

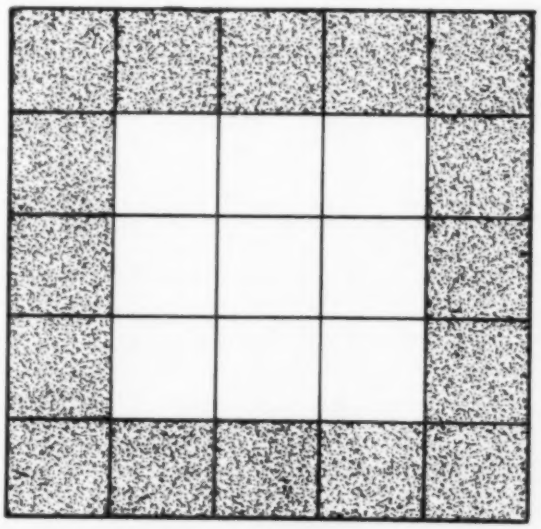


Figure 7. Perimeters of wall-to-wall ceilings require additional lamps.

Heating

Except for the cold light of the aurora borealis and some phenomena of flora and fauna, there is no known light source which doesn't "heat with light." The energy of light sources wasted as heat has been a lighting problem for years. Pres-

With an office building designed for current recommended lighting levels (from 30 to 200 fc, depending on the task), harnessing the heat of the lighting system becomes a very interesting possibility. The new Georgia Power Company Building in Atlanta has been (a) designed for current lighting levels and (b) planned for the lighting system to be the building's heat source, with a design temperature of 10 degrees above 0 Fahrenheit. The structure is a typical office building in design and general layout, 22 stories above ground with two basements below street level. There are varied occupancies—executive suites, clerical offices, IBM machinery areas, corridors, washrooms and all other typical things found in large office buildings. Since the building was designed twice, once before new office lighting levels were established by IES, later redesigned to meet new levels, there was an excellent opportunity for comparison.

With the adoption of the new lighting levels throughout the building, it was immediately apparent that the Btu's generated by the lighting could not be dealt with conventionally. Design temperature in Atlanta for heating systems is +10 degrees. The lighting system, even using fluorescent exclusively, produced slightly more Btu's than required by +10-degree design. It was found that both heating and cooling would be needed at the same time, on the same floor, on cold days—heat for perimeter offices, cooling for interior offices, even on a day 10 degrees above zero.

Consequently a dual duct or "hot and cold" deck system was planned. This system involves the use of mixing boxes fed by hot air ducts and cold air ducts controlled by zone thermostats (see drawings). The mixing box is the air delivery source for the particular area or zone being heated or cooled and delivers whatever temperature air is called for by its particular thermostat, within the range of 53 to 90 degrees. Heat from the recessed troffers, which constitute the lighting system, is collected from the plenum and introduced into the hot air duct system. Thus, it is carried from the interior offices, which are being cooled, to the exterior offices, which are being heated. This system not only utilizes heat from the luminaires to heat the building in winter, but its real bonus is that in summer it affords a means of collecting and exhausting this heat to the outside. This greatly reduces the amount of air conditioning which otherwise would have been needed to cool the building.

For heating at night, when the lights would not ordinarily be in use, a very tempting and simple solution seemed to be to put the lighting on each floor on night set-back thermostats. It was decided,

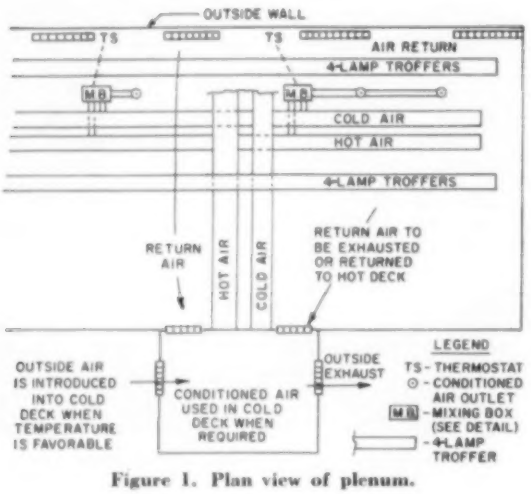


Figure 1. Plan view of plenum.

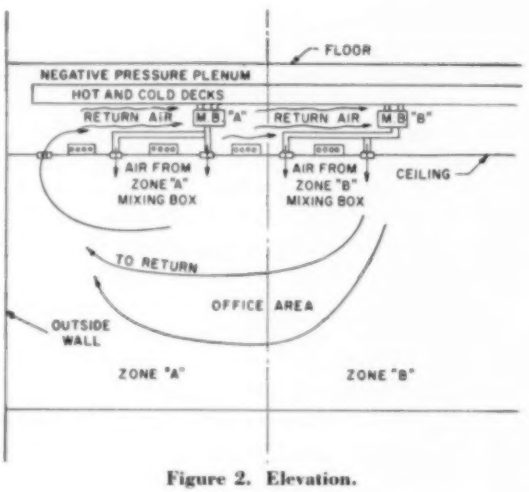


Figure 2. Elevation.

With Light

By J. B. BROWDER

ent-day illumination levels and advances in building design, however, put a new light on this "waste." Read how the lighting system for one new office building was designed to take over, completely, the heating of the entire building.

however, that the wear and tear of frequent lamps starting and the doubtful effect on the public of seeing the Georgia Power Building blinking by entire floors on cold nights would be too much. Solution was the installation of resistance heaters under the windows of the outside offices and in the hot air ducts. This took 87 kw per floor or a total of 1906 kw which operates only at night or on very cold days, below +10F.

Conclusions

Some rather interesting general conclusions were evolved from the study of the two lighting designs, before and after adopting the new recommended levels. With the building being quite typical of new office structures, these may serve as useful rules of thumb for similar installations.

• Current IES recommended levels applied to various typical office tasks, "minimum on the task at all times," resulted in average illumination level throughout the building of 100 fc. Specific applications vary, of course, from 30 to 200 fc, but they *average* 100 fc.

• Fluorescent source wattage required to produce this level, *within* acceptable brightness ranges, was 8 watts per square foot.

• Lighting system provided 27 Btu's per square foot which is available for heating; 36 Btu's per square foot were needed for air conditioning.

• First design of the building (for 40 fc average) indicated a need for 850 tons of air conditioning, which was to have been provided by heat pumps. Later design, to 100 fc, average, necessitated an increased in air conditioning tonnage from 850 to 1050 tons, or 24 per cent. Of these 1050 tons, 528 were required for the lighting alone, the balance for people, machines, windows, etc.

• Change added over $500,000 to cost of air conditioning, wiring and luminaires, as compared to the first design. Increase in cost per square foot was $1.40; total electrical and air conditioning costs are now $7.50 per square foot.

• A new concept was applied in collecting and using and collecting and expelling lighting heat.

• New concepts in luminaires were necessary to provide 200 fc within brightness limitations.

• It made some electrical and mechanical engineers burn some midnight oil and wonder where this industry is going next.

• The answer is up to us—the field is unlimited.

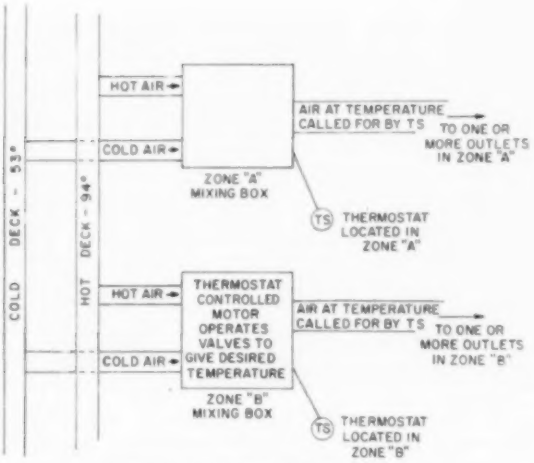

COLD DECK - 53°
HOT DECK - 94°
HOT AIR
COLD AIR
ZONE "A" MIXING BOX
AIR AT TEMPERATURE CALLED FOR BY TS
TO ONE OR MORE OUTLETS IN ZONE "A"
TS
THERMOSTAT LOCATED IN ZONE "A"
HOT AIR
COLD AIR
THERMOSTAT CONTROLLED MOTOR OPERATES VALVES TO GIVE DESIRED TEMPERATURE
ZONE "B" MIXING BOX
AIR AT TEMPERATURE CALLED FOR BY TS
TO ONE OR MORE OUTLETS IN ZONE "B"
TS
THERMOSTAT LOCATED IN ZONE "B"

Figure 3. Detail of mixing box.

Building Statistics

- Height—22 floors above street level. Total area—350,933 square feet.
- Two basements—48,973 square feet.
- 270-car parking garage—89,659 square feet.
- Typical floor—11,540 square feet.
- Service voltage—266/460.
- Service entrance—16 parallel sets of 500,000 cm.
- Two main breakers—4000 ampere, parallel.
- Connected load—8000 kw.
- Estimated demand—4305 kw.
- 1000 tons air conditioning—two 500-ton units.
- 50-ton heat pump for auditorium, telephone office, load dispatcher's office (24 hour operation).
- 90 kw of lighting per floor.
- 87 kw of resistance heating per floor.
- Under window heaters—500 watts each.
- Total electric load—23 watts per square foot.
- Total building cost (without land)—$7,400,000.

AUTHOR: Sales Manager, Georgia Power Co., Atlanta, Ga.

Here and There With IES Members

Residential lighting meeting, sponsored by Puget Sound Section, attracted approximately 100 members and guests for talk by Miss Rose M. Coakley, lighting consultant, Thomas Industries, Inc., Louisville, Ky.

Three new Sustaining Members from Georgia Section sign their IES membership applications as Saylors Andre (standing, left), Chairman of Georgia Section and R. R. Gibson (right), local Sustaining Membership Chairman, look on. New IES supporters, from left to right: Roy Edwards, William LeRoy Edwards, electrical consultants; O. V. Scott, O. V. Scott Electric Co., electrical contractors; Walter C. Fink, Jr., Senior Fluorescent, Inc., maintenance service.

Students at Florida Section's fundamentals course in Sarasota were welcomed to first session (photo at left) by Section Chairman, Kenneth D. Brumbaugh. R. G. Slauer (IES First Vice-President), the first lecturer in the course, is seated next to blackboard at left. In photo at right,

J. W. Pettyjohn, Jr., Westinghouse Electric Corp., Atlanta, discusses floodlighting at the last meeting of the course. Forty-one students, representing power companies, electrical wholesalers, contractors, electricians and architects, were registered for the five-session course.

LIGHTING NEWS

15th Residence Lighting Forum Launched in New Jersey

The recent formation of the New Jersey Residence Lighting Forum has increased to 15 the number of these IES-affiliated groups devoted to the study and promotion of good home lighting. This newest Forum, sponsored by the New Jersey Section of IES, held its organizational meeting in mid-March and elected John A. Sahlman, Public Service Electric and Gas Co., Newark as its first chairman. Other officers chosen were: *Vice Chairman*, Kenneth Huck, Reliable Electric Co., Newark; *Secretary*, Robert Thompson, General Electric Co., Newark; *Treasurer*, Leo Rutenberg, architect, Kearny; *Members at Large*, Morton Gillman, Superior Electric Co., Newark; Robert Keleman, Witte Electric Co., Clifton.

Guest speakers at the Forum's first meeting were Eve Freyer, Residential Lighting Consultant, Westinghouse Lamp Division, and Chairman of the National IES Residence Lighting Forums Committee, and John F. MacDougall, Chairman of the New Jersey Section.

In her speech, Miss Freyer outlined the growth of forum activity from the organization of the first Residence Lighting Forum in Chicago in 1934 to the present activities in 16 cities in the United States and Canada. She covered such successful programs as the New York Forum's annual inspection trip to well-lighted residences, Atlanta's public garden lighting display, Detroit's annual full-day residential lighting meeting for the education of various local groups and the residential lighting equipment exhibits which have been presented under the sponsorship of both the New York and Minneapolis-St. Paul Forums. Mr. MacDougall's talk covered the aims and purposes of residence lighting forums.

One of the most popular services operated by the National Forums Committee is the residential slide library which, at present, contains 12 sets of colored slides and scripts of outstanding residence lighting jobs. Slides, available without charge for Forum meetings, may be obtained from John Michel, Office Manager, at IES Headquarters, 1860 Broadway, New York 23, N. Y.

New Forums organized this year, in

EXECUTIVE Committee of newly-organized New Jersey Residence Lighting Forum seen here at first official Forum meeting. Left to right, seated: Kenneth Huck, Vice-Chairman; John A. Sahlman, Chairman; Leo Rutenberg, Treasurer. Standing: Robert Thompson, Member at Large; (J. F. MacDougall, Chairman of sponsoring New Jersey Section); Morton Gillman, Secretary.

FOLLOWING the business half of the New Jersey Forum meeting, guest speaker, Eve Freyer (center), Chairman of the National IES Residence Lighting Forums Committee, chats with William S. Till (second from left), Vice-Chairman, New Jersey Section; John A. Sahlman (to Miss Freyer's left), Forum Chairman; and some of the new Forum's members.

addition to the New Jersey group, are the Coastal Bend Forum in Corpus Christi, Texas, and the Hillcrest Forum in western Massachusetts. Other flourishing Forums are located in Atlanta, Chicago, Dallas (North Texas), Detroit (Michigan), Kansas City (Heart of America), Minneapolis-St. Paul (Twin Cities), New York City, Phoenix (Arizona), St. Louis, Toronto and Washington, D. C. The Salt Lake City Forum has been inactive this year, but expects to resume activities in 1960-1961.

Lighting Exposition/Conference Held in Los Angeles

Five seminars in industrial, school, office, store and outdoor lighting keynoted the lighting conference held in conjunction with the 10th Biennial Electrical Industry Show and first Lighting Exposition, March 23-26 in Shrine Exposition Hall, Los Angeles, Calif. The sessions, attended by 1365 persons, were devoted to the analysis of visual requirements and the practical solution of lighting problems encountered in meeting the higher lighting levels recommended by IES as a result of the research done by Dr. H. R. Blackwell.

Knox Bourne, vice-president of McGraw-Hill South Pacific District, was the keynote speaker at a Kick-Off Luncheon after which George J. Taylor, vice-president in charge of research, Day-Brite Lighting, Inc., St. Louis, Mo., and immediate past president of IES, introduced the conference program with a discussion of the IES interpretation of the Blackwell results. Mr. Taylor's presentation included studies which alleged that in plants incorporating higher levels of illumination, linked with proper design, resultant benefits may be measured tangibly in terms of higher production, fewer rejects and industrial accidents, and less absenteeism and personnel turnover. Augmenting the conference sessions were displays and demonstrations of the newest lighting equipment.

The Electrical Show and Lighting Exposition was sponsored by the Electrical Maintenance Engineers Association of California. Urban Beh, consulting lighting engineer, Newport Beach, Calif., was general chairman of the lighting conference with Roy H. Kreyser, Los Angeles Department of Water and Power, serving as chairman of the steering committee.

Program for the lighting conference included:

Industrial Lighting—Chairman and speaker—Robert Clubley, Large Lamp Department, General Electric Co.—Lighting in the Electronic Age.

School Lighting—Chairman—Bill F. Jones, Smoot-Holman Co. Speakers—Charles D. Gibson, Director of School Planning, State of California, and John M. Chorlton, Toronto Board of Education—Design for Seeing—The Facts About School Lighting.

Office Lighting—Chairman—James D. Bond, Lighting Dynamics. Speakers—G. J. Taylor, Day-Brite Lighting, Inc.—Modern Trends in Office Lighting; J. S. Hamel, Consulting Engineer—Integration of Lighting and Air Conditioning.

Store Lighting—Chairman—Jerry Silvers, Globe Illumination. Speakers—Mr. Silvers, Edward Balogh, Sunbeam Lighting Co. and Don Romanoff, Lighting Dynamics—The Art of Lighting for Merchandising.

Outdoor Lighting—Chairman—Paul Ogilvie, Pacific Union Metal Co. Speakers—James M. Dowtin, General Electric Co.—Street and Highway Lighting; A. L. Pryor, Consulting Engineer—Parking Area Lighting; William S. Shalda, Shalda Mfg. Co.—Architectural and Building Floodlighting.

Playland, Pa. Site of Electrical Exposition

The development of electrical equipment, supplies, electric heat and lighting "from drawing board to utilization" was the theme of the fourth electrical exposition sponsored by the Electrical Association of York County, Inc. on May 17-19. Held in Playland, Pa., the exposition featured approximately 50 exhibits demonstrating new developments in the electrical field.

In keeping with the idea of investigating all phases of product development, a speaker-discussion session on May 17th was introduced by talks concerning the manufacture, marketing, specification and utilization of electrical products and equipment. On the following day, speeches by John J. Neidhart, manager, Application Engineering, Miller Co., Meriden, Conn. and George Rees, Regional Engineer, Westinghouse Lamp Division, Philadelphia, Pa., considered the various aspects of hi-frequency and high-output lighting and mercury and luminous panel light sources.

Polish Power Experts Visit U.S. Electrical Facilities

As part of a technical exchange program between the United States and Poland, a group of six Polish power specialists visited the U. S. during the month of May to tour electric power and equipment manufacturing plants. This trip followed a visit by a United States delegation, in August, 1959, to electrical facilities in Poland.

The visitors inspected the facilities of

(*Continued on page* 13A)

EXHIBITION floor at Shrine Exposition Hall, Los Angeles, during 10th Biennial Electrical Industry Show and Lighting Conference, March 23-26. More than 6000 people visited the show, sponsored by the Electrical Maintenance Engineers Association of California, with 1365 registered for the lighting conference sessions. In photo at right, Urban Beh (right), consulting engineer and general conference chairman, discusses highlights of school lighting session with speakers, Charles D. Gibson (left), director of school planning, State of California and John M. Chorlton, Toronto Board of Education. Other conference sessions covered industrial, office, store and outdoor lighting.

LPI Trend luminaire provides high-level illumination at the work surface with engineered brightness control. In a typical installation with a white ventrolens diffuser, brightness on desks is only 800 footlamberts compared to brightness of 2100 footlamberts for a conventional baffle-type unit in the same installation.

New LPI Trend luminaire provides high-level illumination, meets recommendations for visual comfort

Visual comfort at high illumination levels is now attainable in schools and offices with the new, economical LPI Trend series.

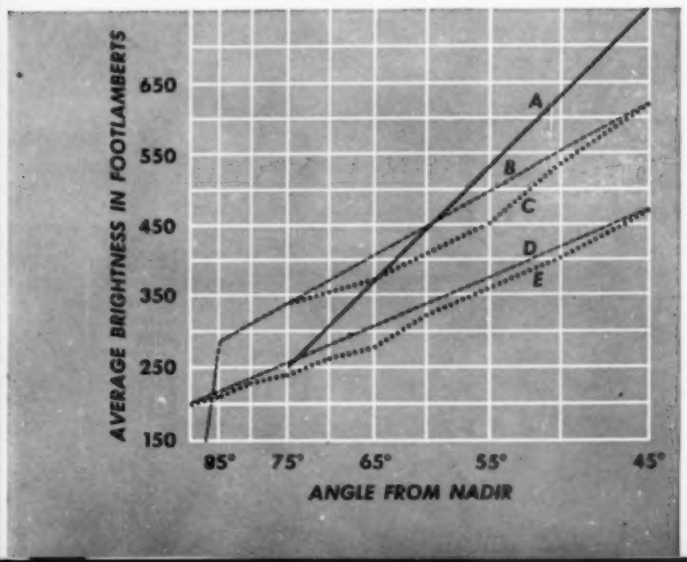
The design of the Trend luminaire combines luminous side panels with efficient diffusers. Both are engineered in shape and transmission characteristics to provide increased foot-candle levels while closely approximating the Illuminating Engineering Society's "scissor curve" for visual comfort.

The new design with luminous, wrap-around side panels makes the Trend luminaire efficient and attractive. Direct glare is well below levels commonly associated with conventional fixtures. The series offers a choice of three types of diffusers—clear ventrolens, white ventrolens to achieve minimum reflected glare, and a new polystyrene egg crate louver which provides 55° shielding both crosswise and lengthwise.

Trend series luminaires are offered in the following sizes for 430 ma rapid-start lamps: 4 ft. x 12 in. unit for two lamps; 8 ft. x 12 in., tandem arrangement for four lamps; 4 ft. x 16 in. for four lamps.

Visual comfort of the new Trend luminaire is depicted in the adjoining chart according to the "scissor curve" method recommended by the Illuminating Engineering Society. Average brightness levels are obtained in the crosswise and lengthwise directions at angles between 45° and 90° from nadir and are plotted on a chart. Also plotted is a straight line representing the I.E.S. recommended brightness limit and straight lines representing the luminaire's own brightness limits in the two directions. Because brightness measurements of the Trend luminaire in the critical crosswise direction fall below these lines, the luminaire may be said to meet I.E.S. recommendations for crosswise brightness control. Lengthwise measurements closely approach these recommendations and are well within the comfortable range.

For complete information on these attractive, moderately priced luminaires, write for LPI's Trend Bulletin.



LPI FLUORESCENT LIGHTING

Lighting Products Inc., Highland Park, Illinois

Plot of average brightness in footlamberts in plane normal to lamps (crosswise of luminaire) and plane parallel to lamps (lengthwise of luminaire) for pendant-mounted LPI Trend luminaire—Catalog No. 7840-4, with CBM ballast and two F40T12/CW/RS lamps

A—I.E.S. recommended brightness limit (75°-45°)
B—Trend luminaire brightness limit—lengthwise
C—Trend luminaire average brightness—lengthwise
D—Trend luminaire brightness limit—crosswise
E—Trend luminaire average brightness—crosswise

"Extensive testing proved that we should specify prismatic shields cast by The Polycast Corporation"

The Mutual Benefit Life Insurance Building, Newark, N. J., is one of the city's most modern landmarks. (Architects, Eggers & Higgins, New York City; Design Engineers, Syska & Hennessy, New York City; Fixture Manufacturer, Gruber Lighting Inc., Brooklyn, N. Y.; Installation, The Beach Electrical Company, East Orange, N. J.)

Says Gunnar Anderson, Manager of Newark's beautiful new Mutual Benefit Life Insurance Building: "Achieving the finest and most efficient lighting system possible was so important to the architects, design engineers and electrical contractors that a special 'mock-up' room was created. All types, shapes and makes of lighting designs were installed and carefully analyzed. The unanimous selection was to use acrylic prismatic shields* made from Du Pont's methyl methacrylate monomer and cast by The Polycast Corp. of Stamford, Conn.

"We've had absolutely no problems with any of the more than 3,500 fixtures made from cast acrylic sheet since they were installed in 1957. And we don't anticipate any for a long, long time. These fixtures provide us with virtually glare-proof lighting—soft illumination that gives maximum efficiency to eliminate eye strain. Also, our maintenance problem is at a minimum with acrylic shields. When the fixtures need cleaning, lukewarm water and mild soap keep them spotless and free from yellowing or streaking. I'd say that this lighting system with acrylic shields has contributed greatly to the beauty of the building."

It will pay you to find out how Du Pont's customers are using Du Pont methyl methacrylate monomer to produce lighting-fixture shields that will give you outstanding service with a minimum of maintenance.

**Polycast acrylic R-14 diamond-pattern shields.*

POLYCHEMICALS DEPARTMENT

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Here and There at IES Contests

Allied Arts Contest winners at University of New Mexico, shown here with Carl R. Albach (standing in center), local contest chairman, are Robert Budnick (left), second place; Milton Creek (right), first; Jimmy Sumida (seated), third. Twelve students competed with designs for kindergarten-primary school.

First prize in the University of Southern California Allied Arts competition was presented to Marvin Futrell (right) by Dean Arthur B. Gallion (center) of the USC School of Architecture. At left is Thomas H. Lehrack, third prize winner. Contest problem was the architectural and lighting design for a de luxe multi-story apartment building.

ALC Award Certificates were presented to designers *and* owners of winning installations in Chicago Section contest. L. to r., back row: Arthur Rosenstein, third, Class II; Harvey Sorensen, first, Class I; Art Rosenberg (representing Wallen Arbetter), joint entry, first, Class II; Olaf Harringer, representing Museum of Science and Industry, top installation in Class II; Jules Rosenberg (second proxy for Wallen Arbetter); Harry Schuman, second, Class II. Front row: A. R. Steadman, owner of winning entry, Class I; Burton Benjamin, joint entry, first, Class II; Mel Cohen, ALC Chairman.

Applied Lighting Competition winners in Philadelphia Section pose with Section and Regional VIP's after announcement of contest results. L. to r., back row: W. P. Graham, Section Chairman; A. V. Schafer, ALC Chairman; Leonard Fritz, first, Class I; C. D. Miller, East Central RVP. Front: C. W. McQuiston, first, Class II; J. R. Rodisch, second, Class II; Robert Keough, third, Class II.

Awards in Southern California Applied Lighting Competition were announced at the same meeting as the Allied Arts awards (see photo above). Norman Tyler (second from right) was top ALC winner in both classes. Shown here with Mr. Tyler, l. to r.: Lew Barrett, ALC Chairman; J. Grant Florin, second, Class I; Ken Chisholm, second, Class II; (Mr. Tyler) Benn Hartmann, Section Chairman.

(*Continued from page 8A*)

ten electric utility companies, observing both nuclear and conventional steam and hydro-electric facilities. Later, they visited the manufacturing plants of three large electrical equipment firms and the Edison Electric Institute.

Members of the Polish delegation included: E. Zadrzynski, Vice-Minister of Power; M. Lech, General Director, United Electrical Power Industry; B. Leszek, Director, Electrical Power Institute; S. Orzechowski, Electrical Power Construction Projects Bureau; Z. Skoczynski, Vice-Director, Electrotechnical Institute and B. Bartoszek, Director, Southern District Electrical Power Works.

HEAD TABLE guests at joint meeting of Montreal Section, Quebec and St. Maurice Valley Chapters included, from left to right: Ed Morwick, Canadian Westinghouse, who hosted a cocktail party prior to the meeting; Gerry Dunnigan, Chairman, Quebec Chapter; Dr. Conrad Godin, President, Catholic School Commission, Trois Rivières; John Chorlton, Toronto Board of Education, Chairman of IES School Lighting Committee and guest speaker at the meeting; Jean Paul Gailloux, Chairman, St. Maurice Valley Chapter.

Three Canadian Groups Hold Joint Meeting in Trois Rivieres

Members of the Montreal, Quebec and St. Maurice Valley Chapters of IES held a joint meeting at the St. Maurice Hotel in Trois Rivières, Que., in mid-April, to hear John Chorlton discuss the problem of glare and brightness ratios. Mr. Chorlton of the Toronto Board of Education, Chairman of the IES School Lighting Committee, stressed the importance of quality in lighting, with particular reference to schools. He discussed the measurement of glare, its relation to proper visual comfort and the importance of controlled brightness, at all times, to facilitate the adaptation of the eye.

Following his talk, Mr. Chorlton presented certificates to graduates of the recent lighting course offered by the Quebec Chapter.

Approximately 60 IES members from Montreal and Quebec journeyed to Trois Rivières to join more than 100 local members and guests at the meeting. Special guests, in addition to Mr. Chorlton, included: Pro-Mayor Benoît Giguère of Trois Rivières; Dr. Conrad Godin, president of the city's Catholic School Commission and Joseph Thomas, IES Director.

Electrical Trade Conference Scheduled for February, 1961

William G. Hills, managing director of the Electrical Institute of Washington, has announced that the Third Biennial Electrical Trade Conference and Exposition will be held at the Sheraton Park Hotel, Washington, D. C., from February 14 to 16, 1961. The Conference has been scheduled to coincide with the observance of National Electrical Week.

Exhibits at the show will feature commercial and industrial lighting, electric space heating, industrial electronic equipment, controls, motors, motor drives, heavy panel boards, safety devices and allied equipment. Conference sessions are planned for each day of the show, from 11:00 a.m. to noon.

The three-day event is being produced under the joint sponsorship of the Electrical Institute of Washington and the Electrical Manufacturers Representatives Association of Baltimore. Paul O. West, president of Doubleday-Hill Co., Washington, has been named general conference chairman.

Complete details of the conference are expected to be available in the early fall. All inquiries for additional information should be addressed to William G. Hills, Electrical Institute of Washington, Pepco Building, Washington 4, D. C.

MEMBERS of Quebec and St. Maurice Valley Chapters and Montreal Section at joint dinner meeting in Trois Rivières, Que. About 160 members and guests attended to hear John Chorlton's discussion of glare problems.

U.S. Attends International Drafting Standards Meeting

This year, for the first time, the United States was represented at the meeting of the International Standards Organization's committee for the unification of drawing practices. Charles E. Hilton, secretary of the Graphic Standards Board, attended the May 10-13 meeting in Lisbon, Portugal, as the American representative. Since the U. S. holds only observer status on the committee, Mr. Hilton had no voting privileges, but was able to report to American industry on the desirability of more active U.S. participation in this standardization work.

(*Continued on page 16A*)

More than 1800 fluorescent fixtures in Old American's new building help create this striking nighttime impression.

110 footcandles of glare-free illumination are maintained throughout, including this attractive lounge for employes.

How Old American Insurance Co. ended the great lighting search with Day-Brite

True to Missouri tradition, Old American Insurance Co. adopted a "Show Me" attitude when considering lighting for their new Kansas City headquarters.

They contacted their local power and light company engineers. Consulted the experts at General Electric's famed Nela Park. Even made their Addressograph Department a "lighting laboratory" and installed competitive fixtures side-by-side.

Result? For lighting effectiveness with high visual comfort, over-all economy with trouble-free maintenance, and pleasing appearance, Day-Brite lighting was the clear-cut choice.

May we show *you*? Call your Day-Brite representative, listed in the Yellow Pages, for the FACTS and FIXTURES! *Day-Brite Lighting, Inc., St. Louis, Mo. and Santa Clara, Calif. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ont.*

Modular design, incorporating Day-Brite Mobilex® with Cleartex® enclosures, permits complete flexibility in arranging offices and work areas.

DAY-BRITE

NATION'S LARGEST MANUFACTURER OF
COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT

(Continued from page 13A)

According to John W. McNair, technical director of the American Standards Association, the American engineer's lack of familiarity with and misunderstanding of European drawings has resulted in much costly confusion and some production errors.

American drawing principles have, to a large extent, been coordinated with those of Canada and Great Britain, through the 1957 American, British, Canadian Conference on the Unification of Engineering Standards. In the United States the standardization of drafting practices has been in progress since 1926 under the sponsorship of the American Society of Mechanical Engineers and the American Society for Engineering Education. All drawing principles and methods, except those relating to architecture, are being published as sections of the *American Drafting Manual*. To date, 14 sections have been completed and it is expected that the work will continue for several years.

Management and Marketing Studied At Syracuse University

The eighth annual session of the Graduate School of Sales Management and Marketing, an executive development program, convened at Syracuse University, Syracuse, N. Y., on June 7 for two and one-half weeks of study. The Graduate School, sponsored by the National Sales Executives International, brings together sales and marketing executives and university professors in an effort to combine scientific techniques and research findings with actual experience in the solution of marketing problems. Conceived within the framework of the sales and marketing executive's responsibilities, the curriculum is designed with an emphasis on the practical, rather than simply the theoretical, aspects of marketing and management.

The first half of the two-year program includes such courses as Recruitment and Selection of Sales Personnel, Financial Analysis and Control, Conference Leadership and Sales Forecasting. Second-year registrants follow a program including Philosophy of Management, Supervisory Policies and Problems, Policy Formulation, Problem Solving and Decision Making and Distribution Cost Analysis.

UCLA Offers Summer Course in Heat and Light Radiative Transfer

A course in thermal and luminous radiative transfer has been announced by the University of California, Los Angeles, for the week of August 15-26, 1960. The course is designed to provide the basic analytical tools and data applicable to the design of systems involving thermal and/or luminous radiation for use by technical personnel concerned with the analysis and synthesis of such power or information transfer systems.

The course, which is being taught by UCLA engineering professor, Philip F. O'Brien, is intended for engineers and scientists working in space vehicle design, infrared, lighting, combustion, heat transfer, radiant heating, weapons effects, human engineering, food processing and other diverse areas concerned with noncoherent radiative transfer.

Material to be covered includes geometry of radiative transfer, basic radiative transfer equation, multi-surface transfer systems, effective transfer parameter, spaces containing absorbing and transmitting media, radiant properties of sources, materials and detectors and systems analysis.

Further information on this course can be obtained from Sam Houston, Engineering Extension, University of California, Los Angeles.

3rd National Lighting Exposition Announced for New York City

The 3rd National Lighting Exposition and World Lighting Forum has been scheduled for March 5-8, 1961 at the New York City Coliseum, according to an announcement by Harold R. Meyer, president of National Lighting Expositions, producers of the show. One-third of the exhibition space had been contracted for prior to the formal announcement of the show, which, according to Mr. Meyer, demonstrates the keen interest of the lighting industry in the event.

(Continued on page 20A)

To All the Members of the Society:

During June each of you will be receiving through the mail an announcement of our 1960 National Technical Conference, scheduled for September 11-16, in Pittsburgh. Complete details of the program will be included in this, but I would like to give you here my assurance of the many values which will be returned for your investment of time and money in attending this Conference. What does the National Technical Conference offer you?

- Outstanding Technical Papers
- Personal contact with technical and business leaders
- A Review of advances in lighting practice and equipment—the annual report of the IES Progress Committee
- Winning application jobs from all the Regions—in the National Applied Lighting Competition
- Pittsburgh's Golden Triangle—the pace-setter in civic and business re-development
- Hospitality and friendship among your fellow members and guests

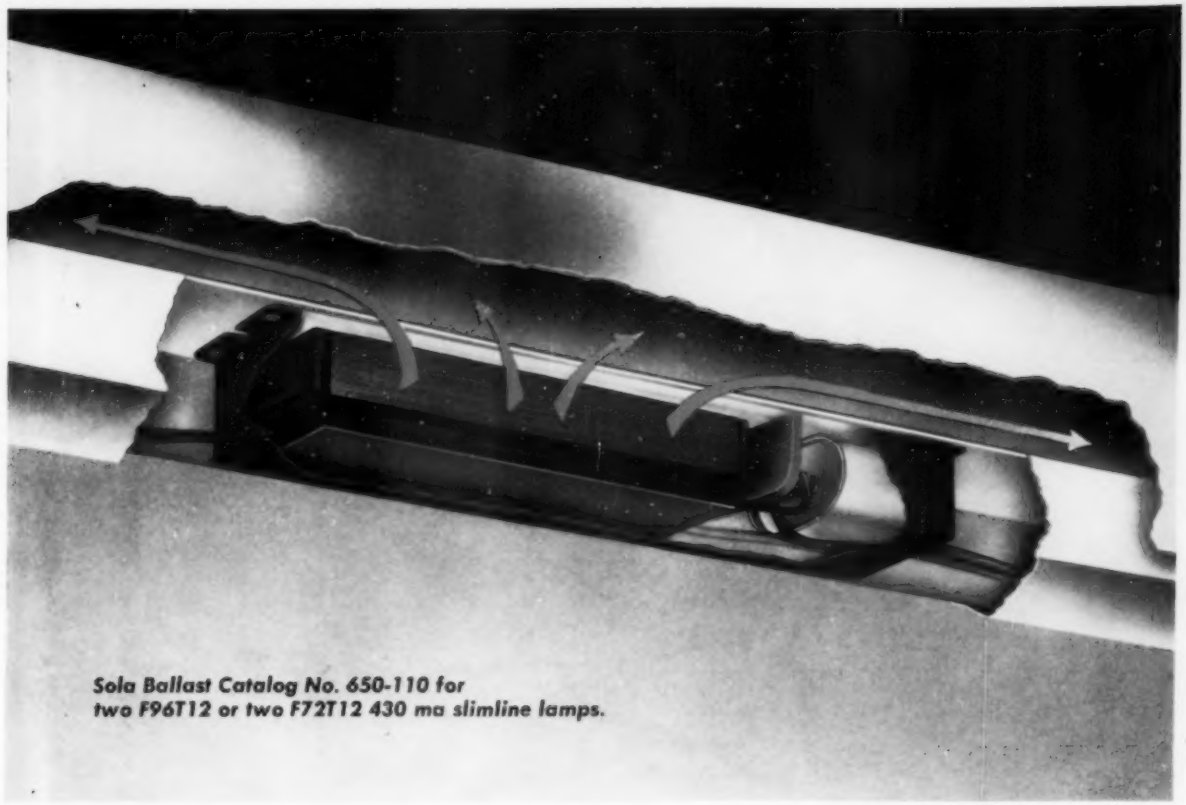
This Conference can take first place among the many dividends of your IES membership.

I will look forward to greeting you at the Conference in Pittsburgh.

Cordially yours,

Joe B. Browder

Joe B. Browder
President



Sola Ballast Catalog No. 650-110 for two F96T12 or two F72T12 430 ma slimline lamps.

Upside-down insides make Sola's new slimline ballast work cooler, dissipate heat faster

Heat, the big enemy of fluorescent ballasts, is well on its way out thanks to a simple but extremely effective move by Sola ballast engineers. They mounted the components of their slimline ballast *upside-down*. This allowed them to remove the fiber insulator from the mounting surface of the ballast case. Now positioned beneath the label surface, it can't trap heat inside the case.

The normal heat generated by the core and coil is transmitted directly to the fixture housing where it is quickly conducted away. The fixture itself acts as a big cooling fin for the ballast. Additionally, a healthy margin of extra space is provided between the capacitor and the core and coil. This extends capacitor life.

All this adds up to a premium ballast that operates cooler, works more efficiently, and lasts longer. Despite this, it costs no more than conventional, hotter-running ballasts. You get premium performance now at no price penalty. The new ballast is CBM-certified to give full light output over its rated life.

You would be wise to capitalize on Sola's upside-down act when you next need ballasts for quality fluorescent fixtures, or for replacement where other ballasts gave up.

Write for Bulletin 3F-FL

SOLA

B P C

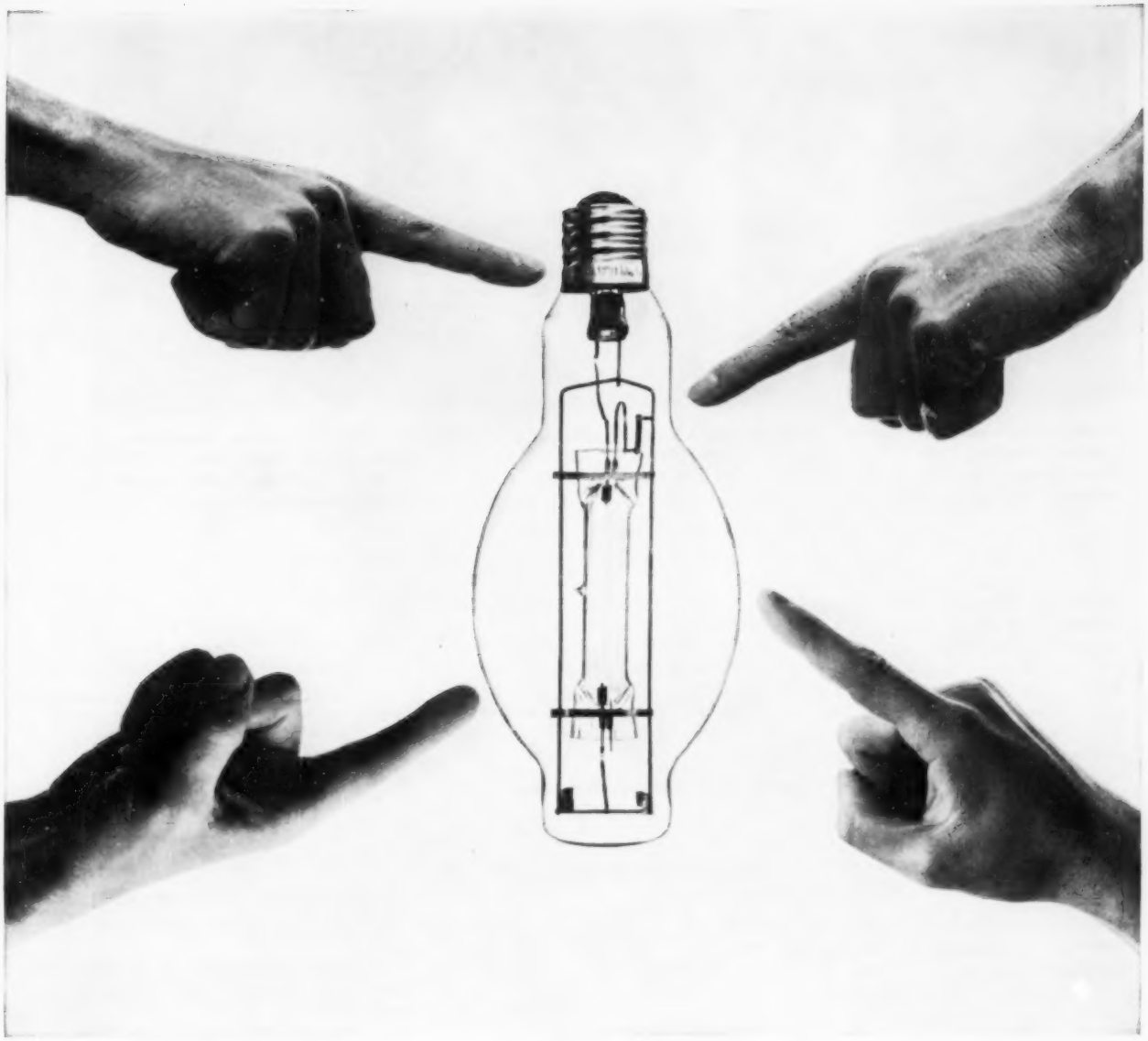
A DIVISION OF BASIC PRODUCTS CORPORATION

SOLA ELECTRIC CO., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 20, Ont.

Mercury lamps may look alike

These Mercury lamps look alike and cost about the same, but one—the Westinghouse Lamp—will deliver more light initially and maintain this high light output longer. It is your most economical choice for industrial and commercial lighting and incorporates all 4 outstanding improvements listed below.

1. Lifeguard™ arc tube to improve lumen maintenance. Even after 10,000 hours of use, these lamps will still give 85% of their initial light output. *This means that 2½ years after you install Westinghouse Mercury Lamps, your plant or streets will have almost the same high level of light as when the lamps were new!*



. . . but four differences make one a better buy!

2. New design electrodes lock in the emission material and insure long life and easier starting.

3. Weather Duty™ construction. Special glass is resistant to thermal shock and corrosive fumes. Moisture, industrial fumes, even snow and rain can't harm these Westinghouse Mercury Lamps.

4. Hi-temp silicone cement holds bases tight for life . . . actually gets stronger as the lamps burn. No drop-outs. Westinghouse even date-codes its mercury lamps so you can check performance.

No matter what type or wattage of mercury lamps you use, you will get more value and light for your money—plus longer, trouble-free service—by specifying and insisting on Westinghouse Mercury Lamps. Westinghouse makes the most complete line of mercury lamps in the industry . . . 100 to 3000 watt sizes . . . in clear, color-corrected and reflector types. Contact your authorized Westinghouse lamp agent or nearest Westinghouse sales office.

YOU CAN BE SURE...IF IT'S Westinghouse

WESTINGHOUSE LAMP DIVISION, Westinghouse Electric Corporation, Bloomfield, N. J.

GRADUATION night for Tampa's Fifth Annual Advanced Lighting Seminar with M. T. Anthony, Vice-President—Sales, Tampa Electric Co. (center in photo at left), presenting a diploma to student Wallace H. Caruthers, Jr., President of Tampa Electrical Contractors Association. At left is James A. Banton, former Southeastern RVP, the guiding force behind the successful lighting course. In photo at right, some of the graduating students.

(Continued from page 16A)

The lighting symposium, a highly successful feature of the 1958 and 1959 expositions, is being carried one step further for 1961. Plans are being completed for a world lighting forum, presenting experts from the United States and Canada, as well as from numerous other countries in panel discussions of lighting problems. An Honorary Committee is planning the Forum program and various educational exhibits to be featured at the show. Specific plans are expected to be announced shortly.

No lighting exposition was planned for 1960, according to Mr. Meyer, to give manufacturers two years in which to develop new products for exhibition. Many new lines are expected to be displayed for the first time at the Coliseum.

The previous National Lighting Expositions, in 1958 and 1959 attracted a total of 40,000 visitors.

5th Tampa Lighting Course Proves Most Successful To Date

IES Sections and Chapters interested in developing successful lighting courses could well follow the example set by the Florida Section. Reports following the completion of the Section's Fifth Annual Advanced Lighting Seminar in Tampa indicate a growing respect and popularity for the course. Statistics on this year's program show an increase over the previous year in total attendance (652 at 6 sessions), number of graduates (103) and diversity of students (representatives of lamp and fixture manufacturers, electrical contractors and wholesalers, architects, school officials and unions).

The course, sponsored by the Tampa Electrical Contractors Association and Tampa Electric Co., in cooperation with IES, covered general lighting design, store and office lighting, ballasts, luminous ceilings, maintenance, residential and exterior lighting. A questionnaire circulated among the students following the last meeting of the course gave the committee valuable suggestions for additional material to be covered in future seminars.

ABOUT PEOPLE

The election of **Walter F. Gips, Jr.** as president of Luminator, Inc., Chicago, Ill., has been recently announced. Formerly, Mr. Gips was vice-president of the company, with which he has been associated for the past ten years.

The Wakefield Co., Vermilion, Ohio, has announced the elections of **Daniel A. Schisler** as vice-president — marketing and **Carl A. Schroeder** as vice-president —production. Mr. Schisler was formerly the general sales manager for Wakefield and prior to that, sales representative in the Texas territory. Mr. Schroeder held the position of secretary and factory superintendent prior to his election as a vice-president.

R. H. Smith, secretary of The Reliance Electric & Engineering Co., has been appointed chairman of the Public Relations Committee of the National Electrical Manufacturers Association. Also announced by NEMA was the election of **Vernon W. Heimberger,** manager of electrical sales, American Steel and Wire Division, United States Steel Corp., as the first chairman of the newly-organized Wire and Cable Division. Elected as vice-chairman was **H. W. Clough,** vice-president, Bleden Manufacturing Co. Elections were conducted at a meeting of the Division's Board of Directors held in connection with the wire and cable industry's annual convention, April 25-27, at the Westchester Country Club, Rye, N. Y.

Arthur L. Appleton, president of the Appleton Electric Co., Chicago, Ill., has announced the election of **Martin J. Lynch** as assistant treasurer of the company. Mr. Lynch, who joined Appleton in 1959 after an association with Price Waterhouse and Co., will also assume responsibility for the administration of the Finance Division. In another appointment, **Donald R. MacLeod** was named director of industrial relations. Prior to joining Appleton Mr. McLeod, who will be responsible for the administration and control of the Personnel, Safety and Training Departments, was connected with various divisions of the Reynolds Metals Co.

At the 41st Annual Meeting of the National Office Management Association, held in conjunction with the 41st International Conference and Office Exposition at the Queen Elizabeth Hotel, Montreal, Que., on May 23, **R. B. Hodges,** Dennison Manufacturing Co., Framingham, Mass., was elected president of NOMA for the coming year. Named as first vice-president was **Dr. J. R. Taylor,** chairman of the Department of General

(Continued on page 23A)

NEW,

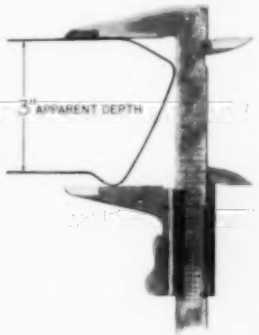
ULTRA-SHALLOW,

ALL PLASTIC

SHIELDED

LUMINAIRES

Go modern fast and easy. Specify and install the new wafer-thin, surface-mounted QPCX7400 Sunbeam Visionaires®. A handsome, wrap-around plastic enclosure gives the fixture a semi-recessed look. The diffuser is completely reinforced in metal and may be opened from either side. Exclusive Sunlux® bottom lens panel assures long lasting luminaire efficiency. No "hardware" mars the clean styling.



write for bulletin A841

SUNBEAM LIGHTING COMPANY LOS ANGELES, CALIFORNIA GARY, INDIANA

Photo courtesy of Aluminum Casting and Engineering Company, Milwaukee, Wisconsin

225 footcandles!

INSTALLATION DATA

Low bay—Twin-mounted Abolite HMFAU-1800 fixtures with 400 watt color-improved mercury lamps. Mounting height 14', with 13' x 12' spacing. Average footcandle level: 225.

High bay—Abolite HMFAU-2400 fixtures with 1000 watt color-improved mercury lamps. Mounting height 24½', with 13' x 12' spacing. Average footcandle level: 180.

Consulting Engineer:
Trester Engineering Co.

Electrical Contractor:
Bentley-Jost Electric Corp.

Abolite lifts the lighting level—This company makes intricate aluminum permanent mold castings. They wanted a higher level of lighting in their foundry to increase worker efficiency. They got it using Abolite fixtures in what some lighting engineers call the most outstanding mercury lighting installation in the country.

In the low-bay area, there's an average footcandle level of 225, yet there's no glare—both vertical and horizontal surfaces are lighted evenly without any deep shadows. The Abolite fixtures give 35° shielding to lamp, direct 18% of light upward through open top to wash out deep ceiling shadows.

Most important, this system costs less than a comparable fluorescent system because fewer fixtures are needed. Maintenance costs are less, too, because the chimney effect of Abolite's open-top design prevents dirt from collecting on lamp and reflector surfaces. Why not try this system with Abolite fixtures on your next job? For full information, write *Abolite Lighting Division, The Jones Metal Products Company, West Lafayette, Ohio.*

ABOLITE *Lighting*

THE JONES METAL PRODUCTS COMPANY
West Lafayette, Ohio

(Continued from page 20A)

Business, Wayne State University, Detroit, Mich. Other vice-presidents elected at the meeting were: **J. H. Jackson,** Canadian Westinghouse Co., Hamilton, Ont.; **J. Greenwood,** Massachusetts Mutual Life Insurance Co., Springfield, Mass.; **J. W. Gawthrop,** Pilot Life Insurance Co., Greensboro, N. C., and **W. L. Myers,** Vegetable Oil Products Co., Inc., Wilmington, Calif.

Dr. Eric A. Walker, president of the Pennsylvania State University, has been elected president of the American Society for Engineering Education for the year beginning July, 1960. Dean **Melvin R. Lohman,** Oklahoma State University, and Professor **Newman A. Hall,** Yale University, were chosen as vice-presidents of the organization, with **Wendel W. Burton,** Minnesota Mining and Manufacturing Co., reelected as treasurer. These elections are the results of national balloting by the 9300 members of ASEE, the national professional organization of college and university engineering teachers.

Plans for Day-Brite Lighting, Inc., St. Louis, Mo., to become a subsidiary of Emerson Electric Manufacturing Co., also of St. Louis, have been given preliminary approval by the boards of directors of the two companies. By terms of the agreement, announced jointly by **W. R. Persons,** president of Emerson and **O. W. Klingsick,** president of Day-Brite, each company will retain its present identity, management, personnel, products and plants.

William P. Lowell, national treasurer of IES and a member of the Society's Council Executive Committee, has been named manager of technical liaison for Sylvania Lighting Products, a division of Sylvania Electric Products, Inc., Salem, Mass., according to an announcement by Frank J. Healy, president of the division. In his new assignment, Mr. Lowell will be responsible for maintaining technical contact with professional societies, trade associations and standardizing bodies in the lighting and electrical industry. Sylvania also announced the appointment of **Theodore C. Sargent** as manager of commercial engineering. Mr. Sargent has been associated with the company since 1943.

Frank Kitzmiller, Jr., has been named to the new position of inter-industry coordinator for the Live Better Electrically Program of the Edison Electric Institute, according to an announcement by

(Continued on page 24A)

SCHEDULED EVENTS

June 20-30, 1960—International Home Furnishings Market, Merchandise Mart, Chicago, Ill.

June 20-24, 1960—American Society for Engineering Education, Annual Meeting, Purdue University, Lafayette, Ind.

June 27-29, 1960—Canadian Electrical Association, Annual Convention, Manoir Richelieu, Murray Bay, Quebec, P. Q.

August 8-12, 1960—American Institute of Electrical Engineers, Pacific General Meeting, El Cortez Hotel, San Diego, Calif.

August 22-24, 1960—National Association of Lighting Maintenance Contractors, Annual Convention, Milwaukee Inn, Milwaukee, Wis. All meetings are open to public.

September 6-16, 1960—Production Engineering Show, Navy Pier, Chicago, Ill.

September 10-18, 1960—Electrical Living Show, New York Coliseum, New York, N. Y.

September 11-16, 1960—Illuminating Engineering Society, National Technical Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

September 21-23, 1960—American Society of Mechanical Engineers—American Institute of Electrical Engineers, Power Conference, Bellevue-Stratford, Philadelphia, Pa.

September 28-30, 1960—Canadian Electrical Manufacturers Association, Sheraton-Brock Hotel, Niagara Falls, Ont.

October, 1960—American Society for Engineering Education, Annual Meeting of North-Midwest Section, Marquette University, Milwaukee, Wis.

October 5-7, 1960—International Association of Electrical Leagues, Annual Meeting, President Hotel, Kansas City, Mo.

October 9-14, 1960—American Institute of Electrical Engineers, Fall General Meeting, Chicago, Ill.

October 13-15, 1960—Optical Society of America Meeting, Somerset Hotel, Boston, Mass.

October 15-20, 1960—American Institute of Electrical Engineers, Fall General Meeting, Detroit, Mich.

October 16-22, 1960—Society of Motion Picture and Television Engineers, Semi-Annual Convention, Sheraton Park Hotel, Washington, D. C.

October 19, 1960—Society of Plastics Engineers, Tooling for the Plastics Industry, New York, N. Y.

October 23-27, 1960—National Electrical Contractors Association, Las Vegas, Nevada.

October 25-27, 1960—American Standards Association, National Conference on Standards, Sheraton-Atlantic Hotel, New York, N. Y.

November 14-18, 1960—National Electrical Manufacturers Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

November 17-19, 1960—Canadian Electrical Association, Engineering Sections, Western Zone, Saskatchewan Hotel, Regina, Sask.

November 21-23, 1960—Canadian Electrical Association, General and Sales Sections, Western Zone, Palliser Hotel, Calgary, Alta.

November 27-December 2, 1960—American Society of Mechanical Engineers, Annual Meeting, Statler-Hilton Hotel, New York, N. Y.

November 29, 1960—American Institute of Consulting Engineers, Annual Dinner, Waldorf-Astoria Hotel, New York, N. Y.

December 5-9, 1960—National Conference on Application of Electrical Insulation, Conrad Hilton Hotel, Chicago, Ill.

January 24-27, 1961—Society of Plastics Engineers, Inc., 17th Annual Technical Conference, Shoreham and Park Sheraton Hotels, Washington, D. C.

January 30-February 2, 1961—Plant Maintenance and Engineering Show, International Ampitheatre, Chicago, Ill.

February 13-16, 1961—American Society of Heating, Refrigerating and Air Conditioning Engineers, Semi-Annual Meeting, Conrad Hilton Hotel, Chicago, Ill.

February 26-March 1, 1961—American Institute of Chemical Engineers, National Meeting, Roosevelt Hotel, New Orleans, La.

March 2-4, 1961—Optical Society of America, Roosevelt Hotel, Pittsburgh, Pa.

I. E. S. National Technical Conferences

1960—September 11-16—Penn Sheraton Hotel, Pittsburgh, Pennsylvania

1961—September 24-29—Chase Park Plaza Hotel, St. Louis, Missouri

1962—September 9-14—Statler-Hilton Hotel, Dallas, Texas

1963—September 8-13—Sheraton-Cadillac Hotel, Detroit, Michigan

1964—August 30-September 3—Fontainbleau Hotel, Miami Beach, Florida

TOGETHER AGAIN, after more than a decade, Edwin F. Guth, Jr. (right), president of Edwin F. Guth Co., St. Louis, Mo., and Frank Jacobs, vice-president, International Brotherhood of Electrical Workers, shake hands to mark end of a 21-year disagreement between management and union.

(*Continued from page 23A*)

Ralph Zeuthen, manager of LBE. Mr. Kitzmiller's professional career has included service with the Duquesne Light Co. in Pittsburgh, Pa., and 12 years with the Edison Electric Institute. As a senior member of the Live Better Electrically staff, he has been a key figure in the activities of the program.

Donald Henning has resigned as chief designer of Curtis-AllBrite Lighting Inc., Chicago, Ill., to open an office under his own name. Mr. Henning, whose new office is in Milwaukee, Wis., specializes in professional engineering service in styling, cost reduction and product improvement.

The appointment of **Raymond H. Rogers** as manager of marketing for the Specialty Transformer Department, General Electire Co., Fort Wayne, Ind., has been announced by Carl H. Rinne, general manager of the department. Mr. Rogers succeeds **Joseph P. Coughlin,** who has been named one of two regional managers in the company's Component Sales Operation.

Hubbard and Co., Chicago, Ill., has appointed **George C. Wright** as southeast division sales manager. With headquarters in Atlanta, Ga., Mr. Wright will be responsible for sales in the major portions of Georgia, Alabama, Tennessee, Florida, Virginia, West Virginia and North and South Carolina.

Ray Gallaher has been named sales manager of Quadrangle Manufacturing Co., Chicago, Ill., according to an announcement by George Arras, vice-president of the company. Mr. Gallaher, associated with Quadrangle since 1938, has been secretary of the concern for ten years.

M. D. Orr, vice-president in charge of marketing, Advance Transformer Co., Chicago, Ill., has announced the promotion of **Ernest H. Gallet** to the position of manager of distributor sales. The appointment was effective May 1. Mr. Gallet joined Advance in 1955 as manager of marketing services, after having been associated with two lighting equipment manufacturing companies. In his new position, he will continue to have his headquarters at Advance's main plant in Chicago.

Prescolite Manufacturing Corp., Berkeley, Calif., has named **John Ludlow** as sales representative for the Salinas, Monterey and San Francisco peninsula areas of California. Mr. Ludlow, who will operate out of the company's home offices in Berkeley, will be responsible for sales of Prescolite's complete line of lamps and lighting fixtures to electrical engineers, architects and distributors in his territory.

Ralph D. Evans has been appointed midwestern sales manager of the Sun-Switch Division, Ripley Co., Inc., Middletown, Conn. (manufacturers of street lighting control products), according to an announcement by C. A. Reeves, vice-president in charge of sales. Prior to joining Ripley, Mr. Evans was associated with the General Electric Co., where he served as product service engineer, district sales manager and sales training specialist.

The Carwin Co., North Haven, Conn. (infusible urethane foam systems and urethane coatings), has announced the appointment of the **H. I. Thompson Fiber Glass Co.,** Blackwood's Division of Los Angeles, as exclusive distributor for 11 western states.

Hal J. Harris has been named district sales manager, southwest district, for Hubbard and Co., Chicago, Ill. Mr. Harris will cover the state of New Mexico and the northwest portion of Texas.

Silvray Lighting, Inc., Bound Brook, N. J., has announced the appointment of the following sales representatives for their recently-organized Consumer Products Division: **T. H. Hall Co.** for California; **William A. Sayre Associates** to cover Connecticut, Maine, Massachusetts, New Hampshire and Vermont; **Gordon C. Trobert** for Florida; **Garth C. Stine** to handle Georgia, North and South Carolina, Alabama and Tennessee; **Hoobler & Schwartz** for Illinois; **Albert J. Schwab** for Maryland, Virginia and the District of Columbia; **A. W. Ricker Co.** for Michigan; **Mark Jackson Co.** for Missouri; **Ogden-Stern Co.** and **Harry Lane & Sons** for New York; **Mentor Lamp & Sales, Inc.** to cover Ohio; **J. Ralph McKeon** for Oregon, Washington, Idaho and Montana and **Eugene R. Loeb** for Wisconsin.

Robert O. Whitesell and Associates have been named as sales and engineering representatives for the Syntron Co., Rectifier Division, Homer City, Pa., effective May 2. Whitesell, with offices in Indianapolis, Cleveland, Cincinnati and Dayton, will represent Syntron in the Central States.

William P. Weber has been named project engineer for K-S-H Plastics, Inc., High Ridge, Mo. according to a recent announcement. Mr. Weber, formerly with the Pittsburgh Plate Glass Co., will devote his energies to developing refinements of production techniques from an engineering viewpoint.

Tri-State Lighting & Supply Co. Inc., Evansville, Ind. and the **Kings-Boro Electrical Supply Corp.,** Brooklyn, N. Y. have been appointed distributors for the Clark Controller Co., Cleveland, Ohio. Both of the distributing concerns will

(*Continued on page 26A*)

ABOVE ALL:

United Air Lines' check-in area, O'Hare Field, Chicago. Lighting fixtures by Curtis-Allbrite Lighting, Inc., Chicago; extruded components by Sandee Mfg. Co., Chicago; molded components by Mid-States Plastics, Chicago; Architect: Ralph Stoetzel, Chicago; United Air Lines Engineer: John V. Foulkes; Consulting Engineer: Kralovec & Best, Chicago; Contractor: W. J. O'Brien Electric Co., Inc., Chicago.

Lustrex perma tone has made possible the design of a new type of fixture in which the complete external shell—all that's seen—is styrene. The wrap-around closures, intermediates, end caps, and extrusions are all snapped in—*without tools!*

The closed-up design keeps out dusts and insects. Use of perma tone also assures color stability, 2 to 3 times greater resistance to yellowing under ultra-violet light, good diffusion, lighter weight, and easier hanging.

Lustrex perma tone is now available in both regular grade, and impact grades for extra toughness and flexibility in snap-fitting, high resistance to abnormal abuse, and lighter weight through thinner walls. Write for technical report on both types, including accelerated aging test results and other valuable data on styrene in lighting fixtures, to Monsanto Chemical Company, Plastics Division, Room 776, Springfield 2, Mass.

Monsanto®

MONSANTO ENGINEER IN **PLASTICS**

(Continued from page 24A)

handle Clark's line of standard electrical controls.

Richard D. Grundy, Pacific Gas & Electric, San Francisco, Calif., has joined the U. S. Health Service. Mr. Grundy, whose new headquarters are in Washington, D. C., will be with the Service for two years.

The Light & Power Utilities Corp. marked the official opening of a new plant and headquarters at Olive Branch, Miss., on May 21 with a program which included plant tours, a dedication, and other activities.

Death

Albert W. Longmate, Chinook Section.

BOOKS AND PAMPHLETS

A Field Guide to Eye-Fi Relighting, available from the National Lighting Bureau, 155 East 44 Street, New York 17, N. Y., $7.50.

This training course in industrial and commercial lighting fundamentals, revised, under the chairmanship of Charles L. Amick, from its original publication in 1954, is designed for individual study. The course includes, in addition to seven technical sections, six sales training chapters and a lighting calculator slide rule.

The technical sections and editors are: "Fundamentals of Lighting & Seeing," W. H. Kahler; "Lighting Design," Charles L. Amick (directions for use of slide rule, Willard Allphin); "Lamps," E. A. Linsday and Morgan Christensen; "Store Lighting," J. J. Neidhart; "Office Lighting," Eric Church; "Industrial Lighting," E. A. Linsday and "School Lighting," George Wakefield.

Specification for Dry Cells and Batteries, National Bureau of Standards Handbook 71, available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

New types and uses for batteries require the drafting of new specifications and the improved performance of batteries justifies some increase in the requirements. Thus the new specifications (this is the seventh edition of the specification for dry cells and batteries, replacing previous specifications) reflect the advances in the dry-battery industry.

The handbook includes many new types of mercury cells and a complete revision in their nomenclature. Specifications are given for the first time on dry cells and batteries for use with transistor circuits. Transistor batteries for transistor instruments are evaluated with new tests especially designed for them. Also included for the first time are dimensions in the metric and English systems and cell designations adopted by the International Electrochemical Commission.

Test methods used to rate dry cells and the specifications in construction and performance which must be met by various types of cells are described.

Footcandle Levels and Interior Lighting Design, published by Westinghouse Lamp Division, Bloomfield, N. J., 60 pages, 10 cents.

A pocket-sized manual containing recommended footcandle levels for a variety of industrial, commercial and residential applications, data on light distribution and measurement and pre-calculated footcandle tables has been published by Westinghouse as an aid to lighting designers. Tables of coefficients of utilization, maintenance factors, footcandle tables for various types of luminaires and light sources, data on fluorescent, incandescent and mercury lamps and information on ballast losses are also included in the booklet.

A section on interior wiring covers uses and types of building wire, allowable current-carrying capacities of insulated conductors, power factors and line current, selection of feeder and branch circuit wire sizes, methods of estimating the capacity of a new wiring installation and a list of the standard wiring symbols.

Copies of the manual may be obtained by writing to Westinghouse Lamp Division, P. O. Box 388, Bloomfield, N. J.

1960 Price List and Index of American Standards, available from the American Standards Association, Dept. PR151, 10 East 40th Street, New York 16, N. Y. No charge.

This publication lists nearly 1900 approved American Standards in addition to the international standards recommendations of the International Organization for Standardization and the International Electrotechnical Commission.

The 1960 Guide to NEMA Standards Publications, available from the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N. Y. No charge.

All existing NEMA Standards Publications, including twenty new books produced last year, are described in this booklet. There are over 200 of these publications for electrical apparatus and equipment grouped in the following classifications: Appliances, Illuminating Equipment, Signalling and Communication Equipment, Industrial Apparatus, Building Equipment and Supplies, Insulating Materials, Insulated Wire and Cable, and Generation, Transmission and Distribution Equipment.

The Lighting of a Great Museum, available from American Lighting Corp., 164 South Street, Hackensack, N. J. 50 cents.

The company which engineered and designed the lighting for the Solomon R. Guggenheim Museum in New York City has published this monograph outlining the details of the installation. Illustrated with photographs, drawings and diagrams, the booklet includes a description of the fixtures built for the museum.

RLM 1960 Standard Specifications for Industrial Lighting Equipment, available from RLM Standards Institute, Inc., 326 Madison Street, Chicago 6, Ill. No charge.

In addition to three new specifications for 1500-ma units (D-4 Fluorescent Semi-Direct Medium High Mounting, SD-3AL Semi-Direct Aluminum and SD-3PE Semi-Direct Porcelain Enamel Units), upward revisions of existing specifications, including new high specifications for materials, new specifications for aluminum reflectors and added provisions for inspection and testing are described. All RLM fluorescent specifications now include, where applicable: grounding of all component parts; continuity of grounding throughout a continuous row; silver-plated contacts in all rapid-start units and synthetic enamel specifications for component parts covering rust inhibiting undercoating, adhesion and hardness.

American Standard Specifications for Fluorescent Lamp Ballasts, C82.1—1960, available from the American Standards Association, Dept. PR152, 10 East 40th Street, New York 16, N. Y., 80 cents.

A revision of C82.1—1958 (second edition), this Standard incorporates changes in the minimum light tolerance for certain rapid-start lamps and includes, for the first time, 1.5-amp rapid-start lamp ballasts. Also covered are ballasts which have rated open-circuit voltages of 2000 volts or less.

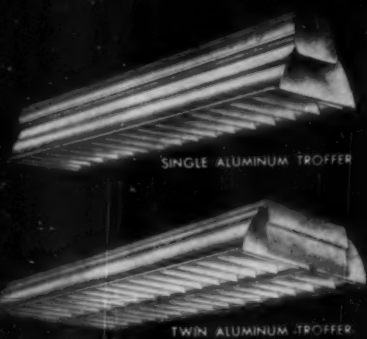
Traffic Engineer, by T. J. Seburn, available from Research Publishing Co., Inc., P.O. Box 245, Boston 1, Mass., $1.00.

This booklet, one of a series of 30 American Occupations Monographs, is an effort to evaluate the requirements and

(Continued on page 29A)

New Aluminum Troffers for POWER-GROOVE . . .

COMFORTABLE, High Footcandle Lighting at LOWER COST than Ever Before Possible



Another Lighting First . . . Miller has just broken through some long standing cost barriers to COMFORTABLE, high footcandle lighting for Offices, Stores, and Public Buildings. Now, you can obtain or provide today's needed higher levels of light at *much* lower cost.

For Example . . . The lighting installation pictured is designed to maintain 120 footcandles in this 60′ x 80′ general office area. Fixtures are Miller's new Twin Aluminum Troffers—2′ x 8′ units with Power Groove Lamps. Compared with conventional, 2′ x 4′ door type recessed systems using 40w Rapid Start Lamps, and providing comparable footcandles and comfort: this new Power Groove system *requires only ¼ as many fixtures*, and *has an initial installed cost 30%-38% lower. Annual Owning and Operating cost figures 14%-18% less.* And, fewer fixtures needed means a less cluttered, more pleasing ceiling appearance. Here, 34% more ceiling area is available for acoustical treatments.

Substantial savings can be realized for both relighting and new construction . . . wherever comfortable, high footcandle lighting is desired. Let us prove to you how such savings are possible for this and other typical installations. Simply *fill out and mail the coupon.* Or, contact your Miller Representative.

LIGHTING BY **miller** SINCE 1844

MAIL TODAY

To: Dept. A-260
THE MILLER COMPANY, Meriden, Conn.

☐ I'd like additional information on how I can obtain comfortable, high footcandle lighting at lower cost with Miller Aluminum Troffers.

☐ Have Your Field Representative contact me.

Name_____ Position_____

Company_____

Street_____

City_____ State_____

eye-li LIGHTING

THE **miller** COMPANY

MERIDEN, CONNECTICUT

Revere Outdoor Lighting Report

Lighting a store front

The Problem: To draw attention to a store front and make it look inviting to shoppers by providing high level, uniform lighting for the wall and sidewalk area.

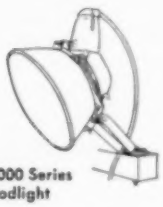
The Answer: Revere 9605 Fluorescent Luminaires were installed to give the high level of illumination desired. Eight-foot units were joined to form a continuous, attractive light source that makes the store look inviting. Each 8-foot unit contains two Very High Output lamps and has two 4-foot doors for fast, easy cleaning and maintenance.

No. 9605
Fluorescent Luminaire

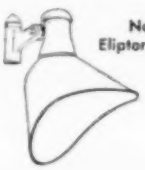
Lighting a race track

The Problem: To illuminate a race track for better visibility, and to provide especially high intensity lighting for dramatic effect at the finish line.

The Answer: Revere Eliptor Floodlights mounted on Revere Hinged Poles No. 199-D-30 were installed along the track. In the grandstand area, floodlights were aimed toward the finish line to heighten the intensity. Revere No. 2000 Series long range floodlights were mounted on the grandstand roof to further illuminate this area.



No. 2000 Series
Floodlight

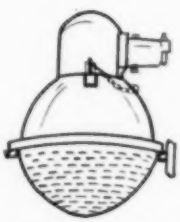


No. 3803
Eliptor Floodlight

Lighting a restricted area

The Problem: To illuminate a roadway encircling a restricted area at the Shippingport, Pa. Atomic Energy Generating Plant for both visibility and security.

The Answer: Revere Star-Lux Luminaires were installed around the entire perimeter of the restricted area, lighting the roadway and a 45° sloping embankment adjacent to it. Star-Lux Luminaires use up to 10,000 lumen incandescent lamps or 250 to 400-watt mercury lamps to provide any of the five A.S.A.-I.E.S. light distribution patterns.



No. 2311-A/2363
Star-Lux Luminaire

Write for Revere's complete catalog of outdoor lighting equipment

OUTDOOR LIGHTING

Revere Electric Mfg. Co. • 7420 Lehigh Ave. • Chicago 48, Ill. • SPring 4-1200

Available in Canada thru Curtis Lighting, Ltd., Leaside, Toronto, Ontario

(*Continued from page* 26A)

relationships of the traffic engineer both before and after entering the profession. Thus the author, himself an associate director of the Bureau of Highway Traffic, Yale University, New Haven, Conn., examines his subject with respect to objectives and responsibilities of traffic engineering in addition to reviewing the educational, social, economic and personal aspects of the position.

Professional Engineer's Examination Questions and Answers, by William S. LaLonde, Jr., published by McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York City. Price: $7.50.

Examples illustrating typical questions and acceptable answers are included in this second edition of Mr. LaLonde's question-and-answer guide to professional engineers' license examinations. The Professional Engineer License, the Land Surveyor License and the Engineer-in-Training Certificate have been used as sources for the questions, which cover such aspects of the examinations as chemical, civil, electrical and mechanical, as well as fundamental, engineering.

The Engineering Index—1959, available from Engineering Index, Inc., 29 West 39th Street, New York 18, N. Y.

Engineering, scientific and technical society publications, engineering and industrial periodicals and publications of government bureaus, engineering experiment stations, universities and other research organizations have been researched in the preparation of this guide to periodical technical literature in the engineering field. Annotated reference items are designed to provide a digest of information on technical, scientific and economic problems as recorded last year in engineering magazines, special bulletins and government reports.

The 1959 Supplements to the 1958 Book of ASTM Standards, available from The American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., $4.00 per part.

Each of the ten part-supplements brings up-to-date the corresponding part of the 1958 Book of Standards by including new standards and revisions adopted in 1959. The book and supplements contain over 2600 standard specifications, methods of testing, recommended practices and definitions of terms for materials.

The 1959 supplements are as follows: Part 1. "Ferrous Metals Specifications"; Part 2. "Non-Ferrous Metals Specifications and Electronic Materials"; Part 3. "Methods of Testing Metals (Except Chemical Analysis"; Part 4. "Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils"; Part 5. "Masonry Products, Ceramics, Thermal Insulation, Acoustical Materials, Sandwich and Building Constructions, Fire Tests"; Part 6. "Wood, Paper, Shipping Containers, Adhesives, Cellulose, Leather, Casein"; Part 7. "Petroleum Products, Lubricants, Tank Measurement, Engine Tests"; Part 8. "Paint, Naval Stores, Aromatic Hydrocarbons, Gaseous Fuels, Engine Antifreezes"; Part 9. "Plastics, Electrical Insulation, Rubber, Carbon Black"; Part 10. "Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes."

NEW MEMBERS

At the meeting of the Board of Examiners on May 18, 1960, the following were elected to membership. Names marked * are transfers from Associate Member Grade.

ALABAMA SECTION

Associate Members:

Harrison, Glen, Alston Electric Supply Co., Pensacola, Fla.
Puckett, R. L., Brown Engineering Co., Huntsville, Ala.
Thrift, C. R., Appleton Electric Co., Birmingham, Ala.

ALAMO SECTION

Member:

Barnes, S. H., Central Power & Light Co., Uvalde, Texas.

Associate Members:

Barr, T. J., Traweek-Healy & Associates, San Antonio, Texas.
Wassa, G. M., 335 Milford Drive, San Antonio, Texas.

ARIZONA SECTION

Member:

*Heubeck, R. L., Yarapai Electric Co. Inc., Prescott, Ariz.

ARKANSAS CHAPTER

Associate Member:

Carlisle, C. E., Duro-Test Corp., Benton, Ark.

ARROWHEAD CHAPTER

Associate Members:

Ball, R. E., Emerson Electric Co., Pomona, Calif.
Schultz, H. R., Paige Electric Co., San Bernardino, Calif.

BLUENOSE CHAPTER

Associate Member:

Mahar, J. J., John Mahar & Son, Halifax, N. S.

CENTRAL ILLINOIS CHAPTER

Associate Members:

Engberg, R. E., Beling Engineering Consultants, Peoria, Ill.
Hall, S. J., Sylvania Electric Products, Inc., Washington, Ill.

CENTRAL NEW YORK SECTION

Member:

*Hall, L. W., Baldwin-Hall Co., Inc., Syracuse, N. Y.

CHICAGO SECTION

Members:

*Bonny, Frank, Bonny Electric Supply Co., Forest Park, Ill.
*Lange, A. W., Holophane Co., Inc., Chicago, Ill.

Associate Members:

Dowrick, A. J., Benjamin Division of Thomas Industries, Des Plaines, Ill.
Shaw, R. A., Sylvania Electric Products, Inc., Melrose Park, Ill.
Turner, Amos, Meissner Engineers, Inc., Chicago, Ill.

CHINOOK CHAPTER

Associate Members:

Kutryk, E. A., Barber Machinery Ltd., Calgary, Alta.
Tompkins, John, Spectacular Productions Ltd., Calgary, Alta.

CLEVELAND SECTION

Member:

Beckstrom, R. A., W. Vance Middough & Associates, Cleveland, Ohio.

Associate Members:

Gelfand, L. J., The H. Leff Electric Co., Cleveland, Ohio.
Houserman, J. P. Jr., General Electric Co., Cleveland, Ohio.
MacKenzie, G. D., The Illuminating Co., Cleveland, Ohio.
Stoutenburg, C. R., Curtis Sales Corp., Cleveland, Ohio.

COASTAL BEND CHAPTER

Associate Member:

Smith, M. J., Sterrett Supply Co., Corpus Christi, Texas.

CORNHUSKER SECTION

Associate Member:

Crawford, Rod, Interstate Electric Supply Co., Council Bluffs, Ia.

DIABLO SECTION

Associate Member:

Fries, F. J. Jr., Ralph H. Goold, Electrical Contractor, Newark, Calif.

EDMONTON SECTION

Associate Members:

Jorgensen, O. E., Jorgensen Electric Ltd., Edmonton, Alta.
Wilson, A. J., Hammond Electric Ltd., Edmonton, Alta.

FLORIDA SECTION

Associate Member:

Huguenin, P. B., Florida Power & Light Co., Sarasota, Fla.

FOREST CITY (LONDON) CHAPTER

Associate Member:

Robbins, W. J., W. J. Robbins Electrical Services Ltd., St. Thomas, Ont.

GEORGIA SECTION

Member:

Erwin, A. D., Jr., Electrical Wholesalers, Atlanta, Ga.

Associate Member:

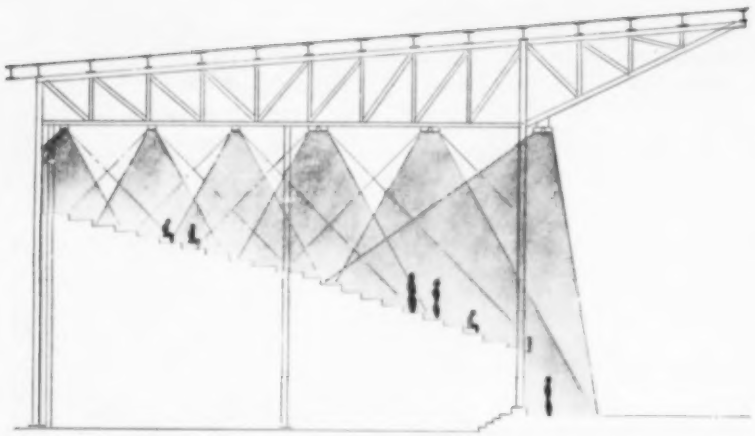
Comer, O. L., Lithonia Lighting, Inc., Conyers, Ga.

GOLDEN GATE SECTION

Associate Members:

Gardner, R. P., Pacific Associated Lighting, Inc., San Francisco, Calif.
Georgeades, Paul, D. Yanow, Consulting Engineer, San Francisco, Calif.

(*Continued on page* 30A)



DISTRIBUTION of heat and light radiation at Maywood Park Race Track, Chicago, shown in an artist's sketch. Six rows of fixtures with quartz infrared lamps produce 30 watts of radiant heat per square foot, 80 footcandles of light, at seat level. Fixture mounting heights range from 14-33 feet. Entire heating-lighting system uses over 1000 kw of electric power.

(*Continued from page 29A*)

Low, J. E. Jr., Stolting Electric Co., Santa Rosa, Calif.

GULF COAST CHAPTER

Associate Members:

Barrow, W. J., John O'Donnell Electric Shop, Mobile, Ala.
Blakney, M. B., Graybar Electric Co., Mobile, Ala.

HAMILTON, ONTARIO CHAPTER

Associate Member:

Wells, C. B., Wells Lighting Service, Guelph, Ont.

HEART OF AMERICA SECTION

Associate Members:

Schrock, J. D., Sylvania Electric Products Inc., Kansas City, Kans.
Yeo, I. C., Yeo & Trubey Electric Co., Manhattan, Kans.

IOWA SECTION

Associate Member:

Krutsinger, F. D., 3713 Ashwood Drive, Des Moines, Ia.

KENTUCKIANA CHAPTER

Members:

*Rueff, E. H., Henry J. Rueff Co., Louisville, Ky.
*Worland, L. A., E. R. Ronald & Assoc., Louisville, Ky.

Associate Members:

Bland, J. O. Jr., Bland Electric Co., Louisville, Ky.
Boden, C. L. Jr., General Electric Supply Co., Louisville, Ky.
Jockell, K. E., K. E. Jockell & Associates, Louisville, Ky.
McClain, Linzy, McClain Electric Co. Inc., Louisville, Ky.
Noonan, E. B., Henderson Electric Co., Louisville, Ky.
Pfeiffer, C. W., 3103 Kipling Way, Louisville, Ky.
Schlaug, L. J., Walter B. Diecks Electric Co., Louisville, Ky.
Storm, S. W., Marine Electric Co., Louisville, Ky.

MARITIME CHAPTER

Associate Members:

Dykeman, L. G., Rothesay, N. B.
Francis, N. W., Norman W. Francis Ltd., St. John, N. B.
Schofield, M. C., Western Wire & Cable Co. Ltd., Lancaster, N. B.

MARYLAND SECTION

Member:

*Forbus, T. R., Line Material Industries, Glen Burnie, Md.

Associate Member:

Wood, P. M., P.O. Box 7427, Baltimore, Md.

MIAMI VALLEY SECTION

Member:

*Grier, G. A., The Dayton Power & Light Co., Dayton, Ohio.

MICHIGAN SECTION

Members:

*de Steiger, Raymond, Jr., Raymond de Steiger, Inc., Roseville, Mich.
*Martin, A. J., The John H. Busby Co., Detroit, Mich.
Pastor, Manuel, Pastor Electric Co., Detroit, Mich.
*Rulketter, J. W., General Electric Co., Detroit, Mich.
*Waite, H. E., Waite Electric Sales, Detroit, Mich.

Associate Member:

Meno, F. J. II, Public Lighting Commission, City of Detroit, Detroit, Mich.

MID-SOUTH CHAPTER

Associate Member:

Williams, E. C., 3563 Bowen Ave., Memphis, Tenn.

MILWAUKEE SECTION

Members:

*Aik, R. M., 312 Congress St., Neenah, Wis.
*Buge, A. J., Buge Electric Inc., West Allis, Wis.
*Garber, R. L., Wisconsin Electric Power Co., Milwaukee, Wis.
*Jasin, J. J., Route 1, Box 6, Bristol, Wis.
*Rainey, J. G., J. G. Rainey Co., Milwaukee, Wis.

Associate Members:

Endres, G. R., Electric Service Inc., Madison, Wis.
Mayer, T. F., Standard Electric Supply Co., Milwaukee, Wis.
Stone, W. P., Stone's Electric Co., Beloit, Wis.

MONTREAL SECTION

Member:

*McCormick, W. J., Sylvania Electric (Canada) Ltd., Montreal, Que.

MOTHER LODE CHAPTER

Member:

*Dean, C. A. Jr., Pacific Gas & Electric Co., Sacramento, Calif.

NEW ENGLAND SECTION

Members:

*Clifford, G. J., Henry L. Wolfers, Inc., Boston, Mass.
MacDonald, J. G., Sylvania Electric Products, Inc., Ipswich, Mass.

Associate Member:

Hurry, W. E., Wheeler-Fullerton Lighting, Boston, Mass.

NEW JERSEY SECTION

Associate Members:

Binder, A. A., American Lighting Corp., Hackensack, N. J.
Merlino, F. J., John C. Morris Co., Jersey City, N. J.
Mott, E. E., General Electric Co., Newark, N. J.
Mugridge, R. B., P.O. Box 125, Neptune, N. J.

NEW MEXICO CHAPTER

Associate Member:

Watson, J. J., Mesa Electric Co., Albuquerque, N. M.

NEW ORLEANS SECTION

Member:

*Goodman, V. L., L. N. Goodman & Assoc., New Orleans, La.

NEW YORK SECTION

Members:

*Folkman, Theodore, John Doris Inc., New York, N. Y.
Goddard, W. M., Office of Alfred Easton Poor, New York, N. Y.
*Sonnenfeld, N. J., Century Lighting, Inc., New York, N. Y.

Associate Members:

Altieri, V. J., Walter Kidde Constructors, Inc., New York, N. Y.
Feldman, Edmund, Creative Designs International, Bronx, N. Y.

NON SECTION

Members:

Bright, M. M., American Factors, Ltd., Honolulu, Hawaii.
*Gianoli H., Napoleon, Napoleon Gianoli H. Electrical Contractor, Lima, Peru.

Associate Members:

Crossman, B. N., The English Electric Co. of Australia, Melbourne, Victoria.
El Kotoury, Ahmed Salah, Philips Orient S.A., Cairo, Egypt.
Samio, Eulogio, Office of the Chief of Fire Dept., City of Manila, P.I.

NORTH TEXAS SECTION

Members:

*Crick, P. A., Paul A. Crick Agency, Dallas, Texas.
Smith, A. H., Roscoe Dewitt, Architect, Dallas, Texas.

Associate Members:

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Telkamp, E. A., Telkamp Electric, Dallas, Texas.

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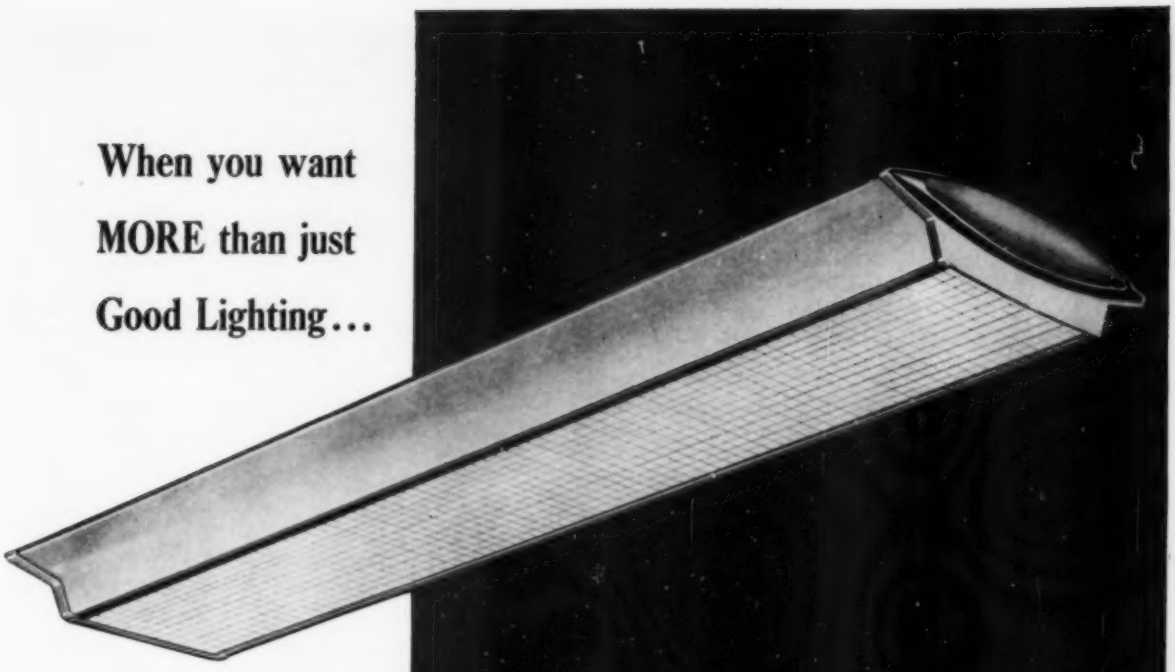
(*Continued on page 48A*)

When you want
MORE than just
Good Lighting...



You want

Sylvania's CLASSIC

Series

Every Classic Fixture
*Now Produced***
Contains the New Solid-Fill
Jefferson DRI-LOK *Ballast!*
**in standard voltage

"Fluorescent lighting fixtures today must do more than provide good illumination. They must also add a distinct element of attractiveness to the ceiling to complement the overall interior décor."

With this concept in mind, Sylvania's Engineering Department, working together with the renowned industrial designing firm of Peter Muller-Munk Associates, created a new fixture family that is truly outstanding.

This is the CLASSIC Series by Sylvania.

The CLASSIC achieves, through its pointed elliptical shape, the elegance and style demanded by today's leading design concepts. This new fixture group features sleek, trim lines; flared, softly-diffusing side panels; and slim shallowness . . . all of which combine to provide a graceful appearance for any interior. To satisfy individual choice, plastic louvers or plastic panels are available.

And the practical aspect has not been ignored either. In addition to its extreme attractiveness, the CLASSIC also provides other important features . . . high-quality lighting characteristics and excellent installation and maintenance advantages.

But a mere description of the CLASSIC is hardly adequate. To appreciate the true beauty and application possibilities of this series you should see the fixture itself.

Write for full information today . . . and ask to have the CLASSIC* demonstrated in your own office.

Sylvania Lighting Products
A Division of SYLVANIA ELECTRIC PRODUCTS INC.
One 48th Street, Wheeling, West Virginia

*Patent Pending

GO MODERN WITH LIGHTING BY **SYLVANIA**

Subsidiary of GENERAL TELEPHONE & ELECTRONICS

FLUORESCENT LIGHTING FIXTURES AND SYSTEMS • BEST FIXTURE VALUE IN EVERY PRICE RANGE

NEW EQUIPMENT DATA

AVAILABLE WITH COUPON

New manufacturers' catalogs and bulletins listed below are available free to readers of ILLUMINATING ENGINEERING by mailing the coupon. Circle the numbers of those items which you want, drop in envelope or fasten securely to back of 3-cent postcard addressed to Publications Office.

(1) FLUORESCENT LUMINAIRES 8-page, two-color folder describes new "Sculpturama" 7500 series of two- and four-lamp luminaires designed for general application. Fixtures feature gently curved, low-brightness metal side panels, and a choice of diffusers. Sunbeam Lighting Co., Los Angeles, Calif.

(2) PLASTICS PROPERTIES Technical service bulletin gives performance data and evaluation techniques for "Lustrex" impact perma tone, new light-stable styrene polymer. Performance curves and pertinent property values are included for this material said to be particularly useful for certain diffuser shapes. Monsanto Chemical Co., Springfield, Mass.

(3) CHURCH LUMINAIRES LL Supplement folder shows many contemporary and traditional luminaires and lanterns, custom-fabricated in various metals for use in churches, public buildings, institutions, etc.; shows some in use in church interiors. Meierjohan-Wengler, Cincinnati, Ohio.

(4) CAST ALUMINUM BULLETS 8-page color catalog F-60 describes complete line of cast aluminum outdoor, bullet-shaped lighting fixtures featuring five modern shapes, with enclosed louvers and lenses, gasket-sealed wiring boxes, and a wide selection of canopy plates. Moldcast Mfg. Co., Newark, N. J.

(5) AIRFIELD RUNWAY LIGHT 12-page Bulletin No. 160 illustrates and details features of "Nine-Fifty" series of flush, prismatic, airfield runway lighting fixtures developed for military and civilian purposes, gives specifications and engineering details. Multi Electric Mfg. Co., Chicago, Ill.

(6) RESIDENCE LUMINAIRES 60-page, full color catalog "Inspiration Lighting" shows company's line of residential lighting fixtures of every description; details each and illustrates them in a variety of room settings, both traditional and modern. Moe Light Div., Thomas Industries, Louisville, Ky.

(7) MERCURY INDUSTRIAL LIGHTING 24-page "Facts" booklet describes company's mercury vapor unit for industrial application and gives eight case histories showing various types of installation Holophane Co., Inc., New York, N. Y.

(8) RECESSED LUMINAIRES 24-page multi-colored catalog illustrates and gives details about company's complete line of recessed and surface-mounted incandescent lighting fixtures for many applications, and shows as well their fluorescent units and pendants. Halo Lighting Products Inc., Chicago, Ill.

(9) ACOUSTICAL METAL CEILING 4-page folder describes "Accesso Metal Pan" fast-installing, easy-access metal ceilings; also company's concealed-accessible suspension system for any acoustical tile. Folder gives full particulars, well detailed with complete specifications. Accesso Ceiling Products Inc., Seattle, Wash.

(10) DISTRIBUTION TRANSFORMERS Two-page bulletin, GEA-5683B, describes company's pole-type transformers with new "Permalex" insulation, said to add 20% loadability with same life as formerly; gives detailed information on features and applications; includes photos, load application and rating tables. General Electric Co., Schenectady, N. Y.

(11) OUTDOOR FLOODLIGHTS New 8-page Catalog S gives cross-section of company's complete line of cast aluminum outdoor floodlights; includes illustrations, specifications and dimensional drawings for wide variety of types for numerous applications. Stonco Electric Products Co., Kenilworth, N. J.

(12) PLASTIC LIGHTING CATALOG New catalog designed for engineering use contains company's present products for use in lighting field, completely indexed and arranged in single-page units for later addition of new items; describes and furnishes properties and photometric data on wide variety of panels. K-S-H Plastics, Inc., High Ridge, Mo.

(13) FLUORESCENT LUMINAIRE Bulletin HL-260 describes new, shallow luminaire with "HI-LO" one-piece, wrap-around diffuser with clear, prismatic bottom and white, low-brightness sides. Sheet gives description and specifications. Metalcraft Products Co., Inc., Philadelphia, Pa.

(14) SOLID-FILL BALLAST Technical Letter 1-008 describes company's new "DRI-LOK" ballast with case, core and coil bonded together with new thermosetting material instead of usual black compound; said to help reduce vibrations and has various other features. Jefferson Electric Co., Inc. Bellwood, Ill.

(15) ARCHITECTURAL LIGHTING New 16-page, two-color catalog reviews interior fixtures and presents four basic interior lighting plans; downlighting, diffuse lighting, wall lighting and accent lighting, showing types of fixtures available in each, and providing installation and specification data. Century Lighting Inc., New York, N. Y.

(16) VINYL LOUVERS Catalog contains complete mechanical and engineering data on rigid vinyl louvers for lighting applications, includes suggested specifications and descriptions of U/L tests for light stability, brightness control, acoustical properties, and other characteristics. Cirvac Plastics, Erie, Pa.

(Continued on page 48A)

Offer good for two months only

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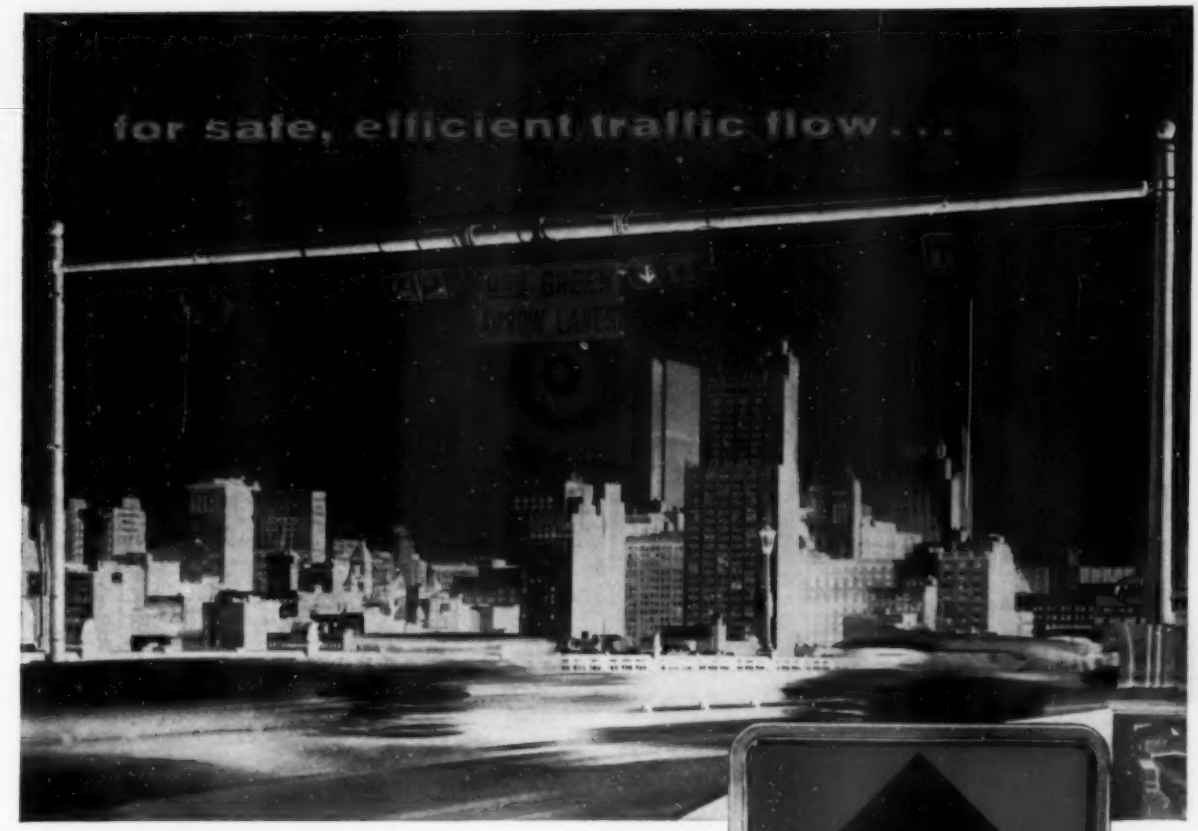


Kopp-engineered *traffic control* SIGNAL LENSES

Specially-designed and custom-produced for traffic control, these 12-inch square lane-control lenses are excellent examples of Kopp-engineered glass at work in today's modern world.

Other very important aids to modern high-speed, high-volume traffic control are the 12-inch traffic signal lenses, engineered by Kopp to produce the type of beam —wide or narrow—needed for various traffic conditions.

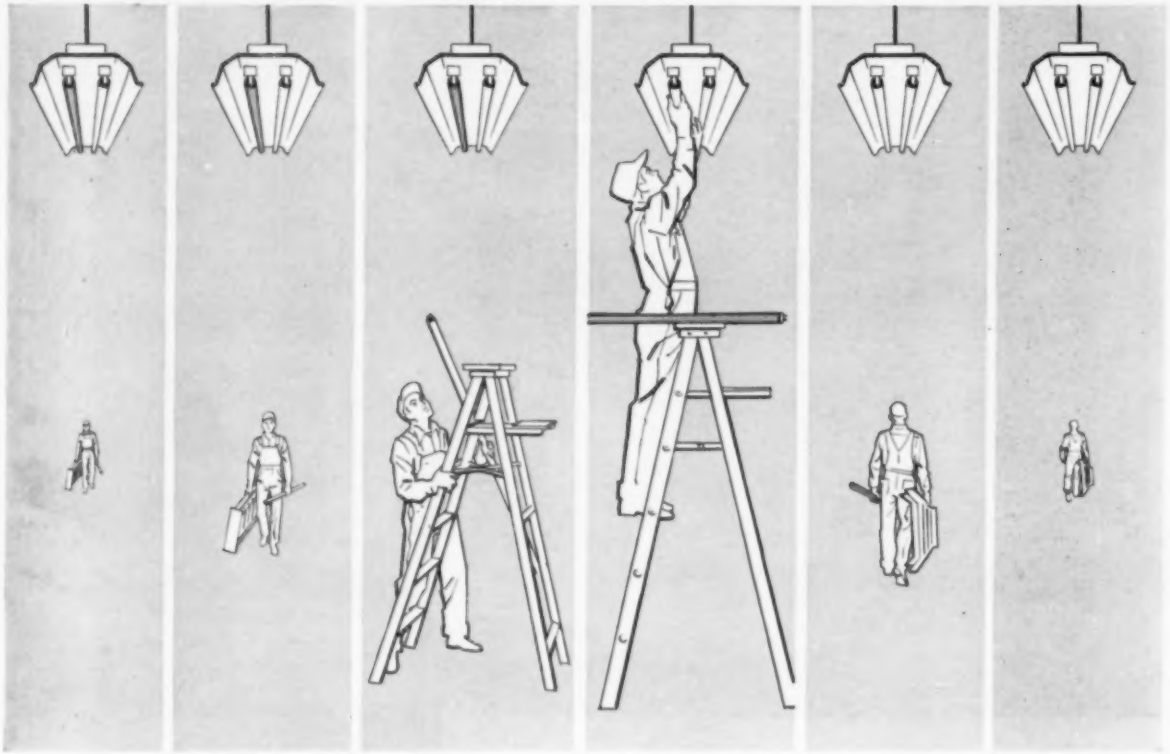
But that's not all. Kopp has engineered more than 1000 types of lenses, color filters and specialized lighting glassware . . . each designed in size, shape and glass composition *to do some specific job*. They are used in aircraft, airports, railroad signaling, emergency vehicles, dental and surgical equipment, swimming pools, and chemical plants—to name only a few.

Perhaps we can help you. Write us about your design problem. Ask for brochure on Kopp Engineered Glass.

Kopp Glass, INC.

Swissvale, Pennsylvania

How long does it take him to replace one lamp?



TWENTY MINUTES! That's the average time it takes to replace one lamp. First the phone call for maintenance, then the requisition, lamp, ladder, hike to the site, lamp replacement, the walk back, disposal of old lamp, put ladder away. And work interruptions among other employees, caused by one-at-a-time lamp replacements are an expensive item not included.

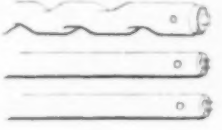
This General Electric Plan can save your customers 26 hours labor on every 100 lamps!

It takes a man about 33 hours to replace 100 lamps if he does it one-at-a-time . . . and less than 7 hours if he does it with this modern General Electric Plan for group relamping. That's a cut-and-dried savings of 26 hours for every 100 lamps your customer uses. Twenty-six times the hourly cost of one maintenance man!

But there's more! With this plan a customer also gets up to 25% more light, 75% fewer work interruptions, 75% fewer buying and stocking headaches . . . and a better looking lighting system.

Records prove this simple plan works best with General Electric Lamps. Why? Because they have a more uniform lamp life. They last most customers well over 2 years . . . with fewer early burnouts. What's more, the plan has a built-in reminder that eliminates record-keeping—tells when it's time to begin another cycle. *Right now* is the best time for you to suggest this money-saving system to each of *your* customers. General Electric Co., Large Lamp Dept. C-022, Nela Park, Cleveland 12, Ohio.

G-E LAMP UNIFORMITY MAKES GROUP RELAMPING PRACTICAL



Powerful Power Groove

Mighty Premium 3

Economical F-40

Progress Is Our Most Important Product

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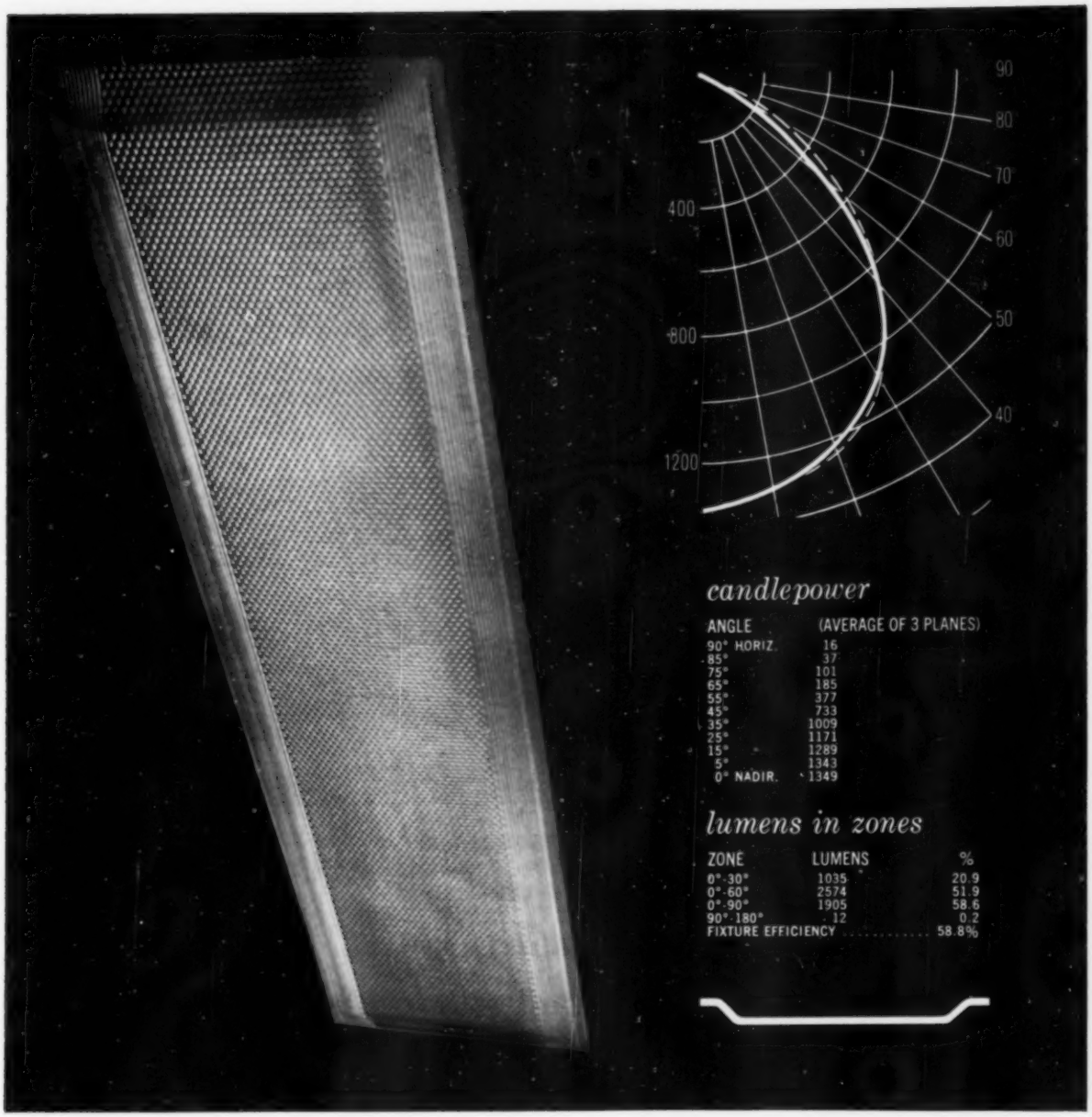


candlepower

ANGLE	(AVERAGE OF 3 PLANES)
90° HORIZ.	16
85°	37
75°	101
65°	185
55°	377
45°	733
35°	1009
25°	1171
15°	1289
5°	1343
0° NADIR.	1349

lumens in zones

ZONE	LUMENS	%
0°-30°	1035	20.9
0°-60°	2574	51.9
0°-90°	1905	58.6
90°-180°	12	0.2
FIXTURE EFFICIENCY		58.8%

Look what happens when you curve the lens panel

Convex or concave, Corning Crystal No. 74 curved lens panels offer an interesting departure from the usual flat lighting surfaces.

Pyramidal prisms in center portion and continuous offset prisms on the sides direct light from tubes and reflector down so that it leaves fixture at angles below the direct glare zone.

Available with open or closed ends, they are suitable for single fixtures or for continuous runs. They are recommended highly for low-brightness, high efficiency lighting. Convex panels are best suited for general office areas where a contoured ceiling appearance is desired. Concave panels are recommended for conference rooms and executive offices.

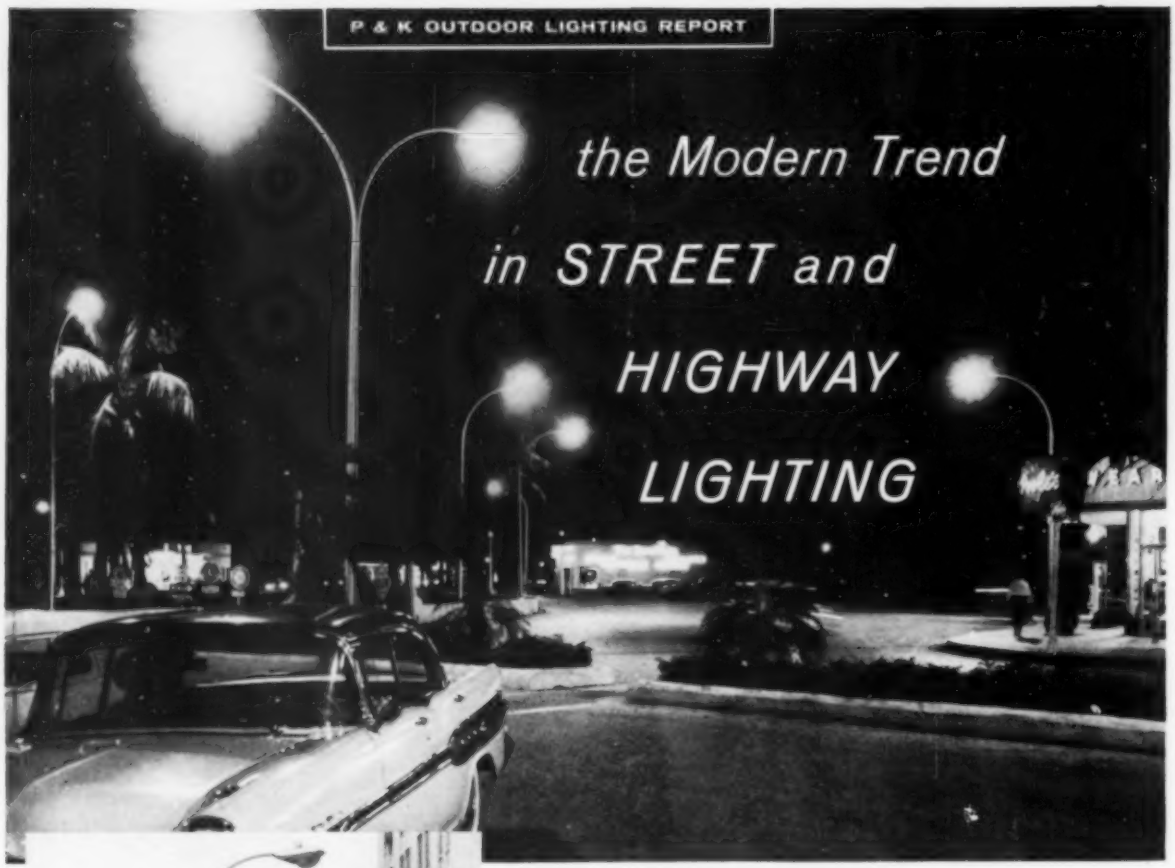
And remember: glass won't warp, sag, bend; it can't discolor; cleans easily, doesn't attract dust.

For complete data on performance and design, write Lighting Sales Department, 61 Crystal Street, Corning, N.Y.

CORNING GLASS WORKS

CORNING MEANS RESEARCH IN GLASS

P & K OUTDOOR LIGHTING REPORT



TOP PHOTO: Traffic circle illumination — West Miami Springs, Florida

LOWER PHOTO: New White Way — White Plains, New York

P&K ALL ALUMINUM

LIGHTING STANDARDS & DAVITS

More than just modern-looking, P&K street lighting standards are modern in total concept. Compare our use of functional design . . . no scrolls, no tie rods . . . instead a strong aluminum tapered elliptical arm — one piece for minimum inventory, fastest assembly and installation. Compare the P&K davit, truly the ultimate in functional design with a style as fresh as tomorrow. What's more, P&K is modern in the materials of construction: to the inherent strength and light weight of aluminum, P&K has engineered designs to meet every load requirement—from the conventional incandescent and mercury vapor luminaires to the new, larger and heavier models in both mercury vapor and fluorescent. And above all, P&K is modern in its elimination of maintenance problems. No painting required — ever. Even the salty sea air offers no hazard to the good looks of P&K standards.

For more information, reserve your copy of the new Aluminum Lighting Standards catalog now. Ask for our helpful brochures ALS and BR-11.

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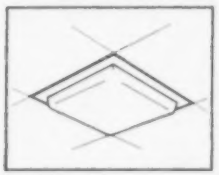
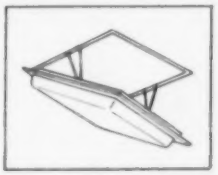
Three sound reasons for specifying

CALCULITES by LIGHTOLIER

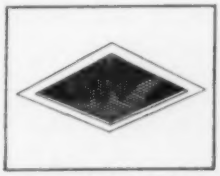
This new coordinated, quality group fits nearly any downlighting need and does it 1. attractively, 2. efficiently and 3. effectively. Example: the Calculite below articulates the ceiling-fixture joint with an opaque metal skirt. The albalite diffuser sends a flood of illumination to the working surfaces. Available: seventeen other models, 96 sizes and finishes, round and square shapes, for wide, medium and narrow light distribution.



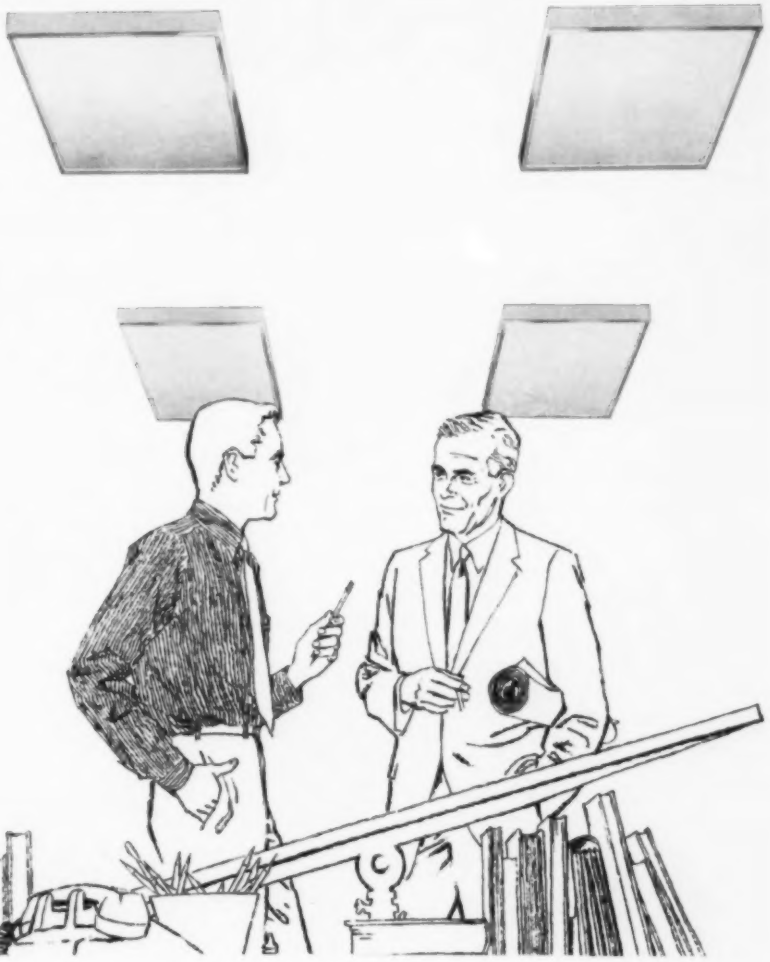
Calculites complement your precision detailing. Example: the new formed glass unit above exactly replaces a 12" x 12" ceiling tile, fits perfectly flush with the finished ceiling surfaces.



Calculites are efficient lighting instruments. Example: Torsiontite spring above permits safe, easy relamping, pulls down from any side. Foam gaskets provide tight seal.



For a simple low-brightness unit exactly flush to the ceiling plane choose the Prismatex Calculite above. In baked white enamel or weatherproof anodized satin aluminum.



NOW
You can get Positive Protection Against
Dripping Compound, Fires & Violent Failures
By Using Ballasts with Built-in KLIXON Protectors
KLIXON PROTECTOR (actual size)

Built-in KLIXON Protectors keep ballasts operating within a safe temperature range under all conditions. The result . . . no dripping compound, no possible fires or violent failures.

Here's how KLIXON Protectors safeguard ballasts . . . assure full ballast life. Should a fault condition occur, the KLIXON Protector snaps the power "off" when the temperature rises above safe operating level. When the fixture and ballast cool to safe operating temperature, KLIXON turns the current "on" again. There is no annoying flicker . . . maximum light output is assured under safe operating conditions.

If the cause of over temperature is external to the ballast, normal ballast life can be expected when the fault has been corrected. If the cause is failure of a component in the ballast, it is necessary to replace the ballast. However, temperature limits are held to a safe level until it is convenient to make this change.

Klixon Protectors Provide Overheat Protection Against:

Lamp Failure
Lamp Rectification
Improper Installation
Poor Maintenance

Klixon Protectors Provide Overcurrent Protection Due To:

Shorted Condenser
Shorted Primary Coil
Shorted Secondary

**Over 200,000,000 KLIXON Controls are in use in refrigeration and heating equipment.*

Write for specification details.

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5406 FOREST STREET • ATTLEBORO, MASS.

Spencer Products: Klixon® Inherent Overheat Motor Protectors • Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers

Ultra-Lux...distinctive style and performance in ultra-shallow two or four-lamp units

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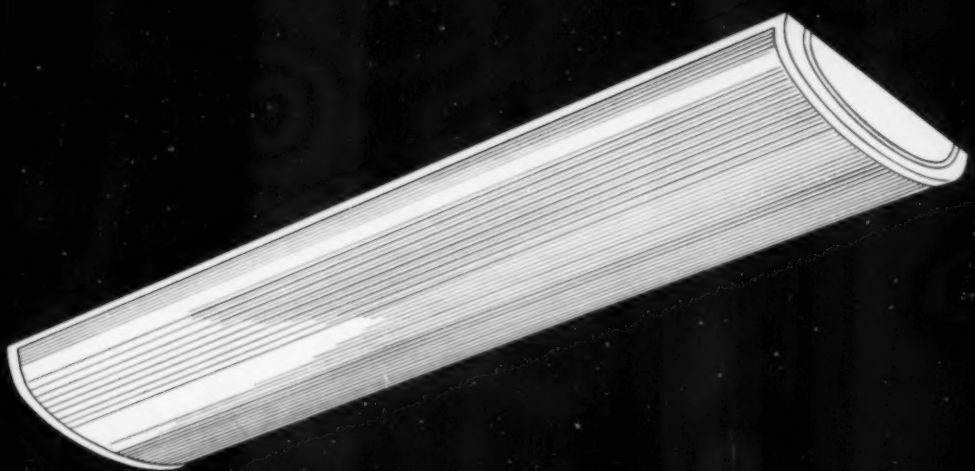


NOW . . . CONTROL LIGHT up, down and at 45°

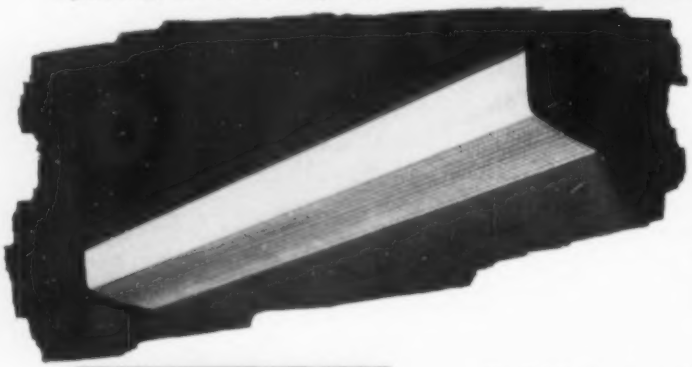
with SHEFFIELD PLASTICS New Wrap-Arounds

FOR CUSTOM DESIGNS

Directo-Lite*

Prismatic bottom provides . . .
- concentrated down-light
- excellent 45-degree cut-off

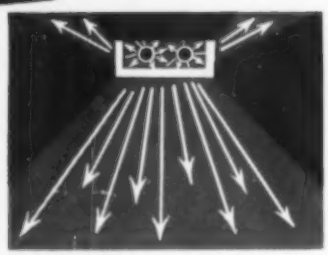
Prismatic sides provide . . .
- refracted light, down on work areas and up to ceiling
- excellent 45-degree cut-off
- glare-free, low surface brightness



Tu-Tone*

Prismatic bottom provides . . .
- concentrated down-light
- excellent 45-degree cut-off

Two-color sides provide . . .
- attractive, 2-color effect at low cost
- glare-free, low surface brightness



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and more efficient illumination on ceiling and work areas is provided by unique Directo-Lite prismatic design.

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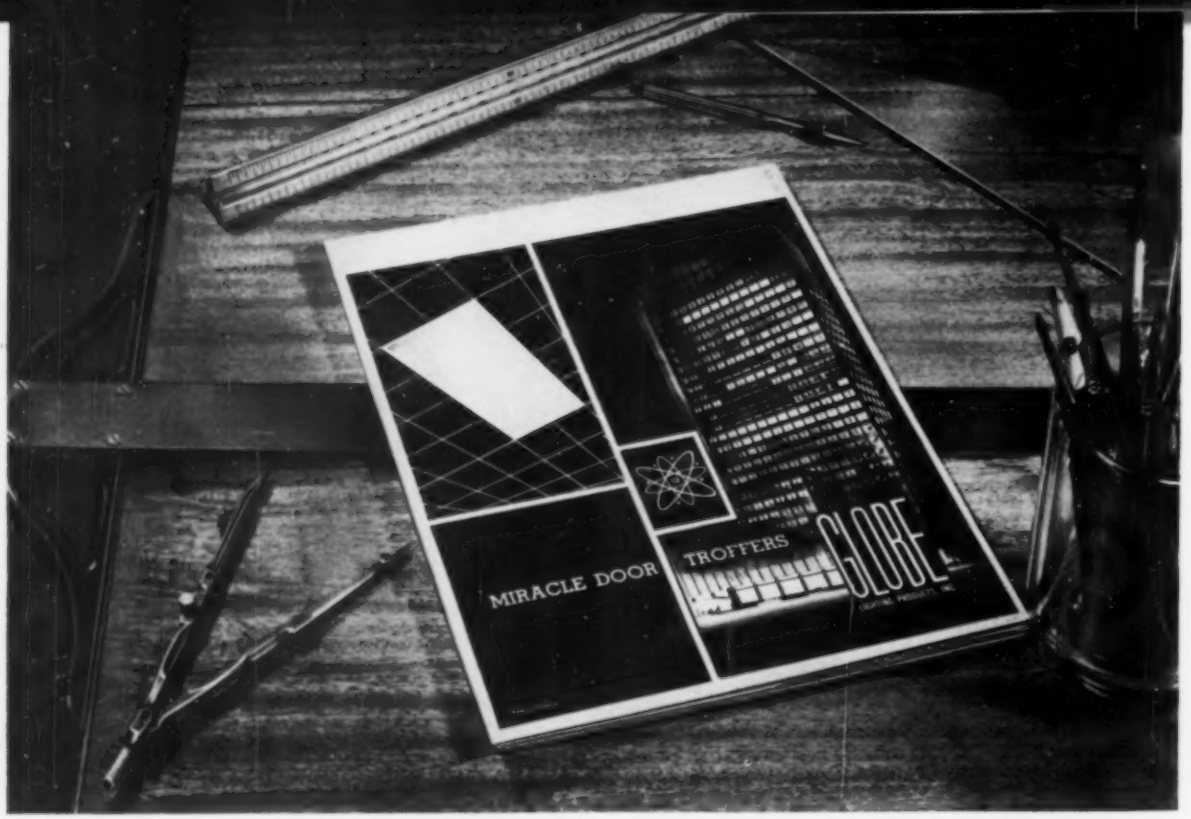

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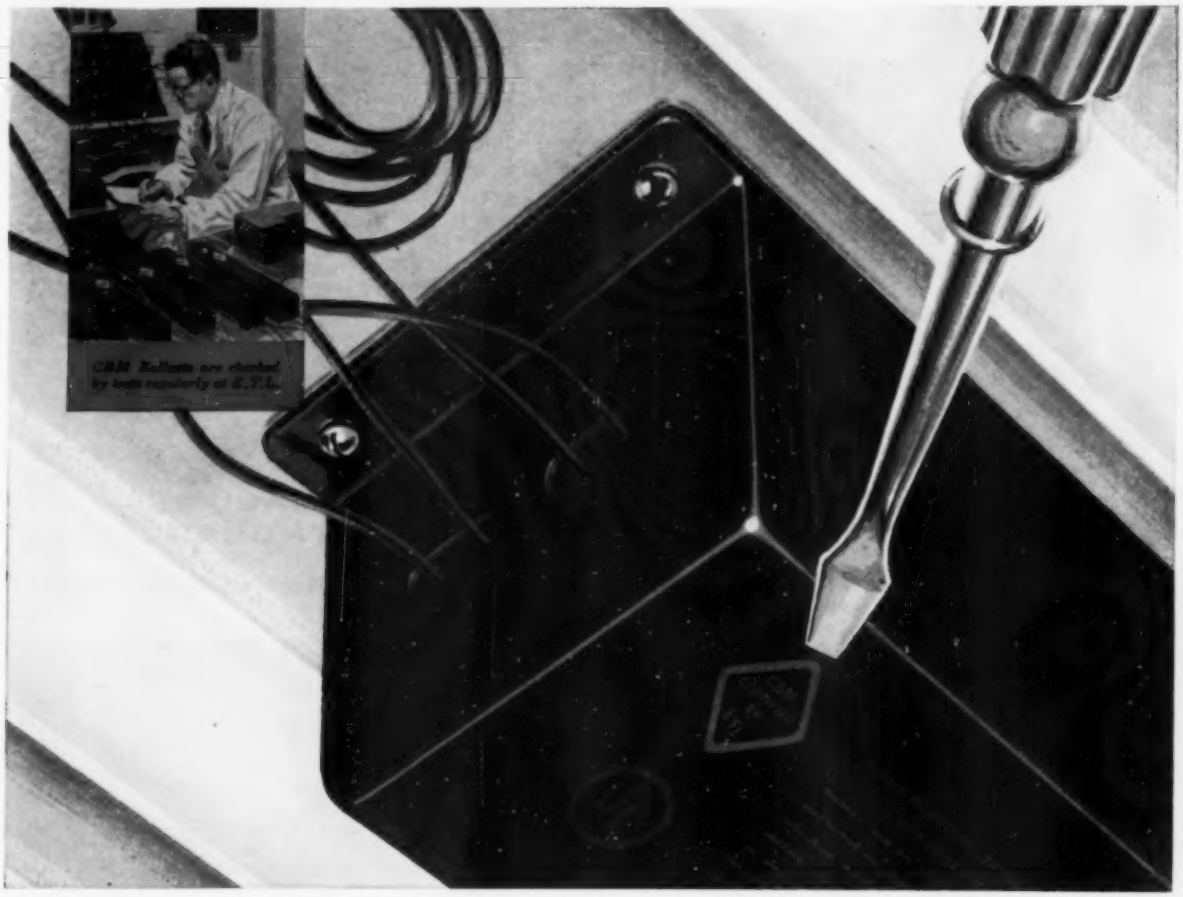

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4-Foot-Long CONTROLENS, singly or in continuous runs, are advantageously used in classrooms, offices, banks, showrooms, libraries, stores, lobbies and laboratories.

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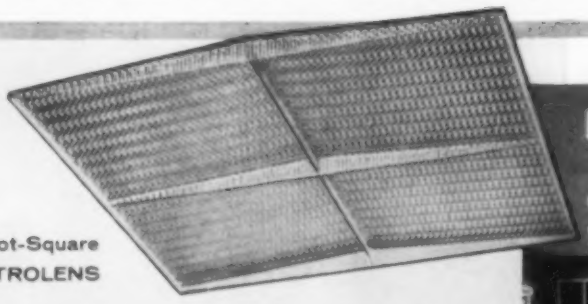

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the ballast that can't drip compound

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Monotube Engineered Lighting Poles

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The illumination of a display room devoted to trays, trophies, jewelry and other gleaming items, represents some special problems. Reflection can get out of hand unless controlled. The task can be a challenge for the architect, contractor and lighting equipment manufacturer.

For the new display room of the L. G. Balfour Company, illustrated, Litecontrol's luminous lens ceiling was a happy choice. The merchandise is gently accented by light of the precise intensity required. There is no excess brightness to distract or strain the eyes. The removable lenses lift out quickly for easy servicing of the fixture.

This equipment is one of Litecontrol's most popular systems. You'll find it and other standard, cost-saving units right in your catalog for your next store, office, bank, school or other commercial installation.

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AREA SHOWN: Showroom
ARCHITECT: Charles G. Everett, Pawtucket, R. I.
ELECTRICAL CONTRACTOR: A. C. Burt, Attleboro, Massachusetts
DISTRIBUTOR: Graybar Electric Co., Inc., Providence, R. I.
FINISHES: Ceiling — Off-White. Trophy Cases — Mahogany
CEILING: Litecontrol Luminous Lens-Ceiling, using Holophane #6024 acrylic lenses, 40 watt Rapid Start strip fixtures on 24" centers
INTENSITY: Average, 75 footcandles in service

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NEW EQUIPMENT DATA

(*Continued from page* 32A)

(17) EXITS AND DRUMS Three new two-color brochures describe company's exit and aisle lights, opal luminaires and opal drum lights, give full specifications and construction features as well as photometric data and lighting curves. Prescolite Mfg. Corp., Berkeley, Calif.

(18) BALLAST BUYERS GUIDE 12-page guide is organized for easy selection of proper ballast, includes specifications and wiring diagrams, showing dimming ballasts as well as weatherproof types; facilitates selection by listing of ballasts by lamp type and current rating. Sola Electric Co., Chicago, Ill.

(19) FLUORESCENT LIGHTING UNITS 4-page condensed folder show many of company's most popular commercial and industrial units and features "Speedomatic" troffers for ceiling lighting systems, includes index of ceiling types, and engineering specifications, photometric data. Smithcraft Lighting, Chelsea, Mass.

(20) RESIDENCE PORTFOLIO Full-color portfolio presentation pictures and describes new line of "Carnival," "Interplay," "Mozart," and "Plexisphere" designs of residential chandeliers and lighting fixtures featuring world-wide designs and materials. Lightolier, Jersey City, N. J.

(21) LIGHTING VINYL Data D-12 describes "Lifeguard 150" new vinyl material for lighting applications; gives properties and specifications of material said to increase light stability to 150% and other details. United Lighting and Ceiling Co., Oakland, Calif.

(22) RECESSED FLUORESCENT SYSTEM 32-page Brochure B-2 features new "Shallotroffer" recessed fluorescent luminaire line with plug-in unitized electrical assembly, gives construction and installation features as well as mounting details; shows eleven different diffuses available and photometric data. Globe Illumination Co., Los Angeles, Calif.

(23) BUILT-IN LIGHTING 104-page catalog "Current Designs in Lighting" covers built-in lighting fixtures, contains installation information as well as technical and photometric data, and a number of installations pictured in separate sections. The Kirlin Co., Detroit, Mich.

(24) LIGHT CONTROL 24-page Bulletin L758W-1 in color provides application and installation data on company's continuously adjustable light control equipment, suggests applications and shows various types available. Superior Electric Co., Bristol, Conn.

(*Continued from page* 30A)

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(*Continued on page* 49A)

(Continued from page 48A)

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(Continued on page 50A)

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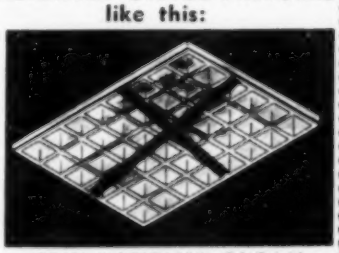

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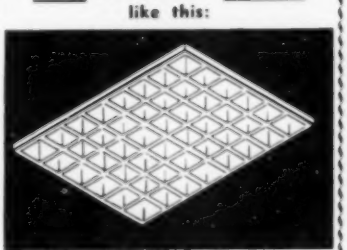

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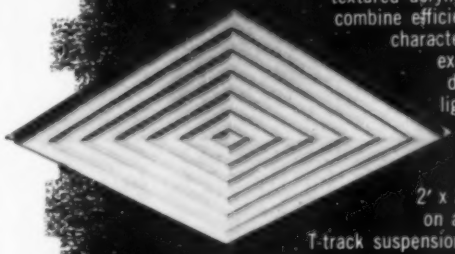

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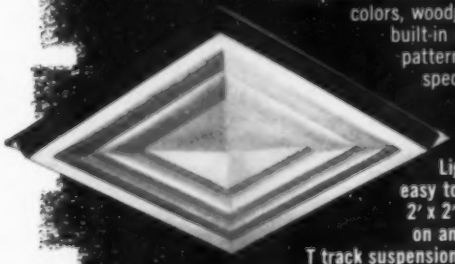

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Boucher, Langis, Institut de Technologie de Quebec, Quebec, Que.
Cote, Bernard, Institut de Technologie de Quebec, Quebec, Que.
Cote, Gerard, Laval University, Quebec, Que.
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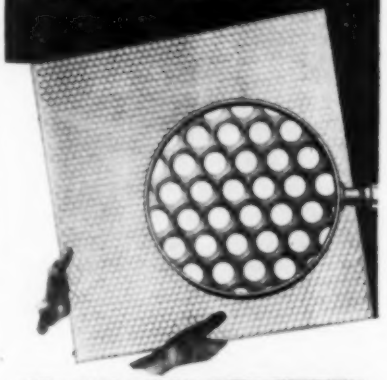

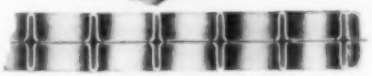

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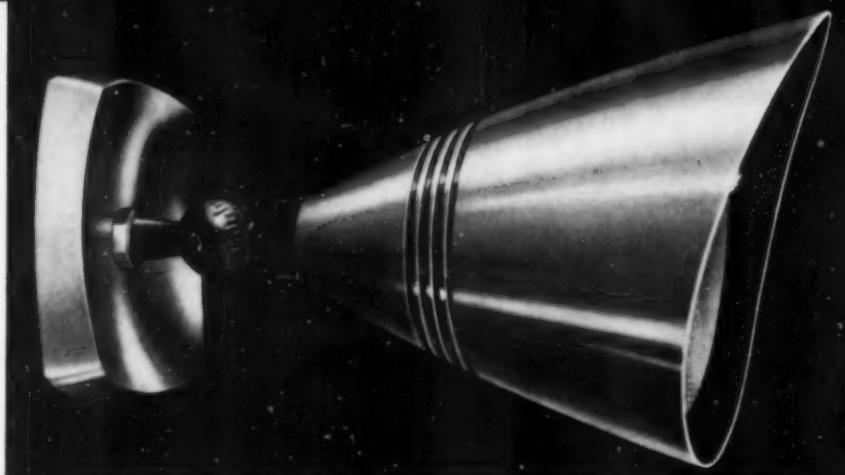

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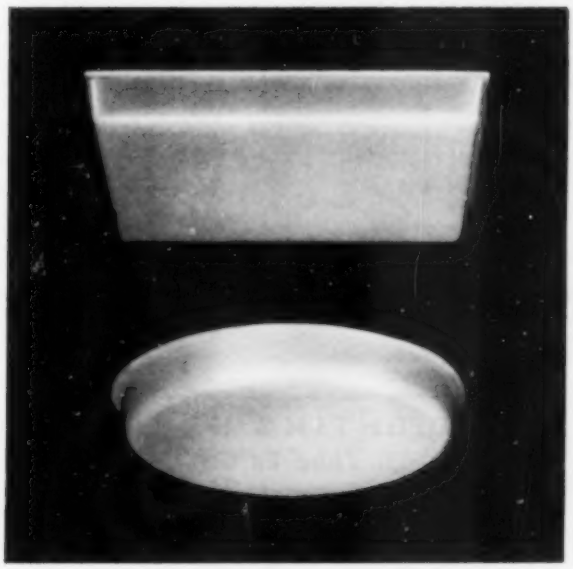

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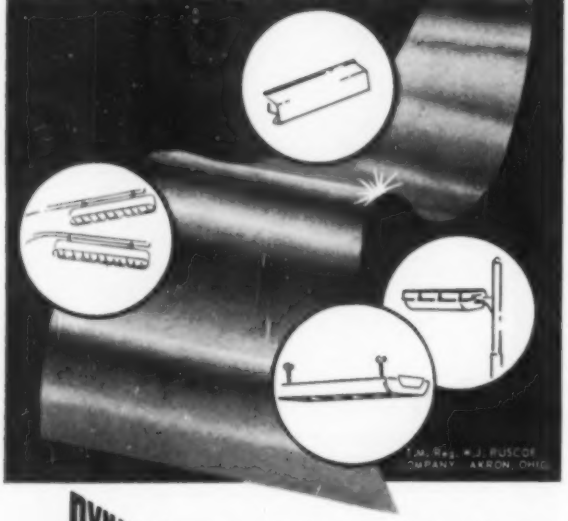

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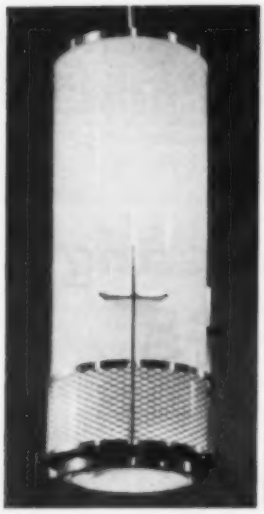

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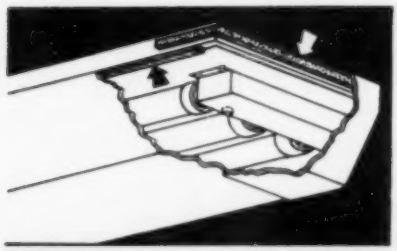

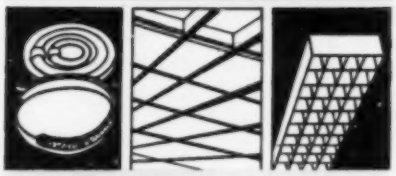

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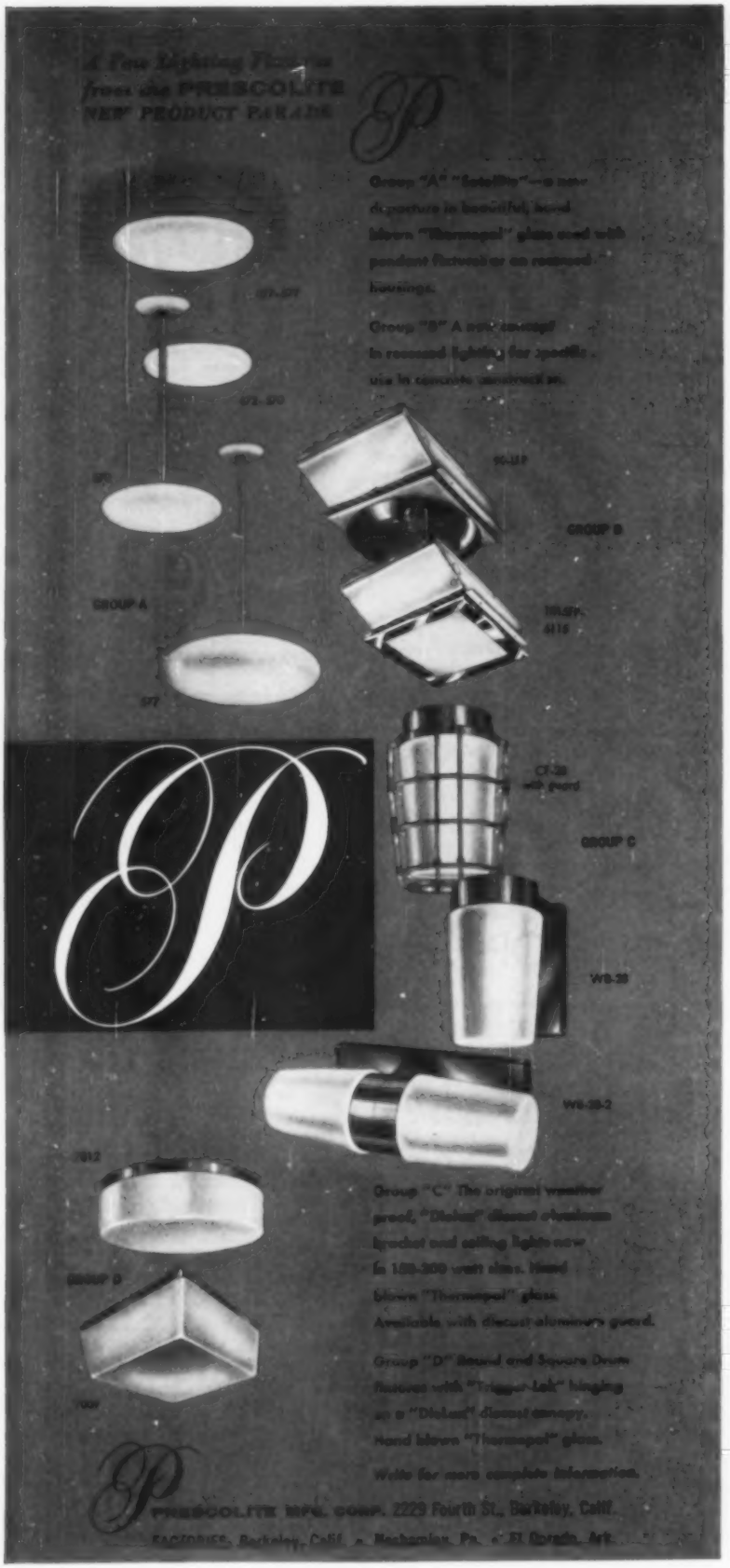

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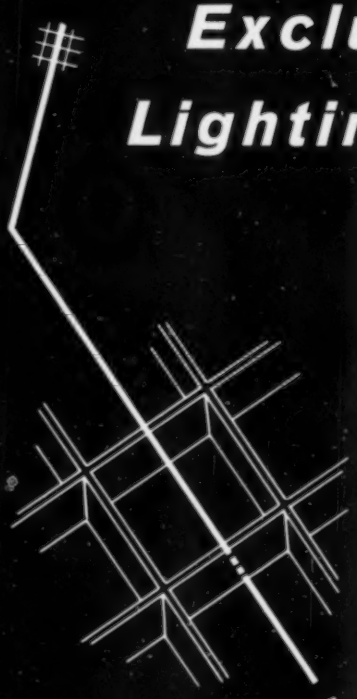

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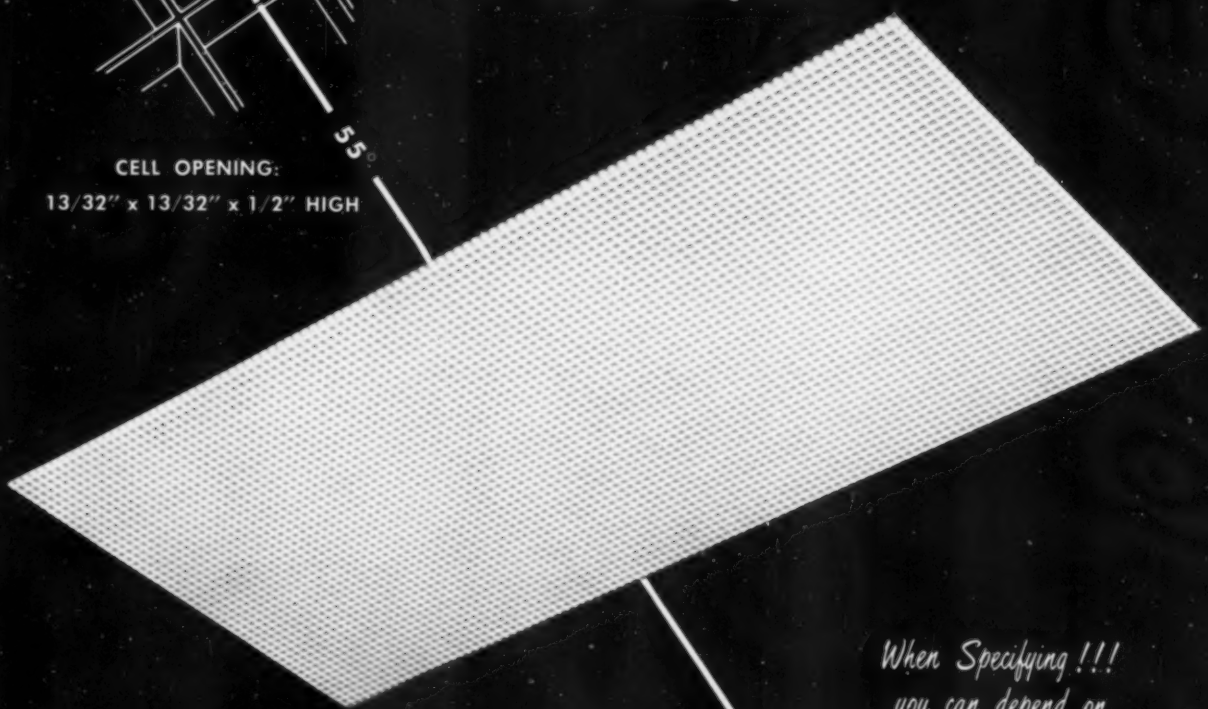

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